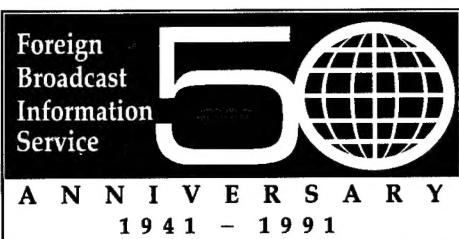


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# ***JPRS Report—***

# **Science & Technology**

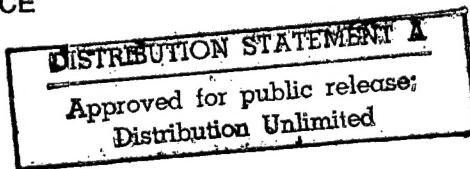
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# Science & Technology

## USSR: Electronics & Electrical Engineering

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### New Methods of Measuring TV Channel Parameters Using Digital Processing

917K0306A Moscow TEKHNIKA KINO I  
TELEVIDENIYA in Russian No 5, May 91 pp 22-25

[Article by V. T. Basiy, L. B. Berezovskaya, D. I. Vikhot, O. V. Gofayzen, Elektron Science Research Institute and Odessa Telecommunications Institute]

UDC 621.317:621.397.132.037.372

[Abstract] The use of analog linear and nonlinear operations performed on TV test signals necessary for analyzing the distortions of TV test signals and measuring the parameters of TV channels due to distortions of the radio pulse components of TV test signals is analyzed and the shortcomings of these operations are discussed. A method of four phases is proposed for increasing the accuracy of TV channel parameter measurements. The method is based on using new signals in which radio pulse components are shaped as components transmitted in any sequence. The method is characterized in that the luminance component is completely suppressed, the radio pulse component envelope is found as a continuous function of time at each moment, and all this is accomplished without the envelope filtering and detection which contribute additional errors. The algorithms for determining the TV channel parameter characterized by TV test signal radio pulse component distortions, i.e., the static and dynamic nonlinearity, amplitude-frequency characteristic (AChKh), differential gain (DU), and TV signal parameters, i.e., chroma signal peak-to-peak value, color timing signal, etc., are developed. A method of determining the effect of the chroma signal on the luminance signal and a method of measuring the difference in the chrominance and luminance signal gain are proposed. A method of measuring the lag between the chrominance and luminance signals is described and its advantages are summarized. It is shown that the proposed test signals are preferable to known signals and make it possible to separate them into the luminance component and radio pulse component envelope as well as identify the phase envelope of this component without using amplitude and phase detection and spectrum limiting operations. The use of these signals increases the measurement accuracy of most TV channel parameters. References 22: 21 Russian, 1 Western; figures 2.

### Monotron: High Definition Projection Laser Cathode Ray Tube

917K0306B Moscow TEKHNIKA KINO I  
TELEVIDENIYA in Russian No 5, May 91 pp 27-29

[Article by A. S. Nasibov, V. I. Kozlovskiy, Ya. S. Skasyrskiy, P. V. Reznikov, Physics Institute imeni P.N. Lebedev at the USSR Academy of Sciences]

UDC 621.385.832.5:621.375.826

[Abstract] The shortcomings of today's projection cathode ray tubes (ELT) with phosphor screen used in television are summarized and it is shown that they can be partially compensated for by special interference filters, absorbing media which improve monochromaticity, collection optics, and other devices which complicate the tube design and often improve one parameter at the expense of another. It is shown that laser CRT's (LELT) are capable of eliminating said shortcomings due to its radiation directivity, brightness, and monochromaticity. Radiation spectra of CRT screens with conventional phosphor used in earlier projection tubes, oxide phosphor used in today's picture tubes, and single crystal phosphor screens are presented and compared to each other. The latter picture tubes have the narrowest spectral lines and are free of additional bands. A new high-definition projection LELT developed at the Lebedev Institute (FIAN) is described. The tube - called monotron - is distinguished by its high resolution whereby the emitting pixel diameter does not exceed 25  $\mu\text{m}$  making it possible to fit 2,000 pixels in one line. The tube is also characterized by the lack of X-ray emission, its electron beam modulator bandwidth (up to 80 MHz), low modulator blanking voltage (30-40 V vs. 200 V of other tubes), and the possibility of quickly replacing the cathode and laser element without replacing the tube itself. The monotron design and specifications are described in detail. A working prototype of a color projection laser tube was developed jointly by the Lebedev Institute, All-Union Television Research Institute, and Radio Engineering Plant in Smela; its total luminous flux reaches 3,000 lm. The picture tube employs II-VI semiconductor materials. References 11: 5 Russian, 6 Western; figures 5; tables 2.

### Comparison of Several TV Image Noise Reduction Methods

917K0306C Moscow TEKHNIKA KINO I  
TELEVIDENIYA in Russian No 5, May 91 pp 34-36

[Article by D. S. Orazalinov, Moscow Communications Institute]

UDC 621.391.837.4:621.397.13

[Abstract] Various sources of noise which distort the TV image and give it a fluctuating grainy structure due to aperture and nonlinear distortions appearing during the optical image conversion into the TV signal, the use of movie film and videotape, multiple videotape duplication, various distortions in communication channels, and demodulation in the TV set are summarized. Methods of reducing this noise which is combined with the legitimate signal at various transmission stages between the TV studio and the TV set are analyzed. In particular, two types of noise reduction methods are considered. The first includes all types of nonlinear processing, such as videosignal level-sensitive gain, frequency-sensitive filtering, and limiting or thresholding

which increase the signal/weighted noise ratio but lead to a certain distortion or loss of video information and thus call for high accuracy of execution. The second is the signal averaging method which, in essence, is a form of frequency filtering. The interframe signal averaging method is also discussed. References 11: 6 Russian; 5 Western.

#### **Cable Television: Ends and Means, Part 1**

*917K0306D Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 5, May 91 pp 41-45*

[Article by A. Barsukov]

UDC 621.397.743

[Abstract] The role of TV, particularly cable TV, in mass media (SMI) under the conditions of its independence from government control is examined using the example of the German experience as presented in data supplied by the AEG KABEL company. The development of cable TV infrastructure in the Federal Republic of Germany (FRG) and the schedule of subscriber fees charged for the installation and use of cable TV, characteristic features of fiber optic communication lines in cable TV and their specifications, safety issues, and specific uses, peculiarities of digital system circuit designs such as video coding, especially differential pulse-code modulation (DIKM), sound encoding, setting up of additional data transmission channels, communication channel multiplexing methods, high speed (565 Mbit/s) signal transmission, and characteristics of optical receivers are examined. The design and operation of an analog optical TV system intended for transmitting four video signals in the PAL, SECAM, or NTSC standards and stereo of mono audio signals at an up to 25 km distance and multichannel multiplexed FM signal transmission are considered. The role of cable TV in teleconferencing is analyzed. Figures 2; tables 2.

#### **On Buildings' Shadowing Effect on Illuminance of Rooms**

*917K0296A Moscow SVETOTEKHNIKA in Russian No 4, Apr 91 pp 1-4*

[Article by D. V. Bakharev, Nizhniy Novgorod Civil Engineering Institute]

UDC 628.921/.928

[Abstract] The field structure of direct and reflected daylight factor (KYeO) components created in rooms by cloudy sky with an open horizon, i.e., in the simplest case of the celestial sphere screening by the plane of the observer's horizon passing through the reference point is analyzed and three characteristic zones, unshaded (NZ), partially shaded (ChZ), and fully shaded (PZ) by the horizon, are identified. The piecewise-continuous direct field component structure which manifests itself as a sharp break in the field level surfaces in isolines on the zone

boundary is demonstrated. It is shown that while the above structure is observed on upper floors of buildings, rooms on lower floors are additionally shaded by the surrounding building. The main patterns of these buildings effect on the magnitude and structure of daylight factor are considered. The shaded fields were analyzed with the help of the LARIS1 program which is an improved specialized modification of the REFLEX program written in the FORTRAN language. The results demonstrate that in any screening situation, the daylight factor field created by the sky light is always a more or less asymmetric combination of the simplest fields; thus, in addition to the piecewise field zone configuration, they display rather common patterns of the structure and daylight factor field magnitude formation in rooms shadowed by surrounding buildings. References 5; figures 5.

#### **Outlook for Laser Processing Applications in Lighting Industry**

*917K0296B Moscow SVETOTEKHNIKA in Russian No 4, Apr 91 p 17*

[Article by S. G. Vologdina, V. M. Ganyuchenko, V. V. Lityushkin, V. A. Nesterov, V. I. Uvarov, Leningrad Electrical Engineering Institute and Lisma Association]

UDC 628.9.002:621.37.826

[Abstract] The outlook for using laser treatment in lighting engineering is examined due to the possibility of combining high-precision processing with the high reproducibility accuracy and the technological versatility of the laser beam as a processing tool, whereby radiation interacts with matter in a nonresonant way since its thermal impact is concentrated and can be easily controlled in the domain of space and time, making it possible to attain local heating and melting and/or evaporation of material. Various types of laser processes used, or being tested for use, in the production of light sources (IS) are examined and the experience accumulated in the field of commercial operation of laser-based precision cutting of tubular vitreous silica glass blanks for specialized and general-purpose lamps, including sodium vapor lamps, is summarized. The use of lasers for cutting precision tubular blanks for making quartz glass optical fibers directly during the drawing of tubes in the furnace is identified.

#### **Illumination of Rooms With Video Display Terminals**

*917K0296C Moscow SVETOTEKHNIKA in Russian No 4, Apr 91 pp 20-25*

[Article by V. O. Gornov, V. M. Karachev, Saturn Plant and Construction Physics Research Institute]

UDC 621.397.331.222(001.5)

[Abstract] Characteristic features of the use of character and graphics displays in all fields of man's scientific,

design, management, and production activity are analyzed and the mechanism of operator sensory and motor activity involved in working with video display terminals (VT) is considered. Measures aimed at maintaining operator visual fitness and preventing fatigue and the resulting psychological and physiological and emotional stress which may lead to severe consequences, especially at such entities as power plants, and result in heavy losses are examined. Various studies in the field of video display terminal room illumination carried out in foreign countries and the standards which govern illuminance at the computer operator workstation are surveyed. Recommendations for ensuring the necessary visual comfort in rooms with commercial character and graphics video display terminals are analyzed. Special systems and facilities for lighting rooms with video display terminals tested and approved for use in European countries will be addressed in parts 2 and 3 of this article to be published later. References: 8 Western; figures 4; tables 2.

### Video Data Compression

917K0290A Moscow TEKHNIKA KINO I  
*TELEVIDENIYA* in Russian No 3, Mar 91 pp 27-31

[Article by A. N. Rachenko, Leningrad Scientific-Industrial Association "Vektor"]

UDC 612.843.31:621.397.13

[Abstract] The problem of television viewing, namely the paradoxical mismatch between sharpness of vision characterized by a 1' angle standard resolution by the human eye and the dimensions of optical receptor fields on the retina ranging from a 5' angle for cones to a 65' angle for rods, is tackled by representing the image in the television receiver by a set of Boolean functions with both line sweep and frame sweep set by a pulse counter. With the aid of a digital-to-analog converter, the lower-order bits are converted into the line sweep voltage and the higher-order bits are converted into the frame sweep voltage. An extra upper segment of the pulse counter reads the sequence of frames in the entire broadcast or in only a part thereof. With the aid of an analog-to-digital converter, a video signal generated in the television transmitter is converted into a sequence of digital readouts. The process of image transmission and compression in such a system is analyzed for accuracy of image approximation, of particular concern being the dependence of this accuracy on the dimensions of the receptor fields. This analysis reveals that the resolving power of the retina is determined not so much by the dimensions of those fields as by the definition of their boundaries. This principle of data processing on the retina is applicable to analogous other techniques, techniques which either involve directly copying the processes of bipolar and ganglionic plexuses with electrical or optical fibers or involve homomorphic mapping. Figures 2; references 8.

### Calculating Minimum Usable Field Intensity of Radio Signal

917K0290B Moscow TEKHNIKA KINO I  
*TELEVIDENIYA* in Russian No 3, Mar 91 pp 31-33

[Article by S. B. Pivovarov, Moscow Institute of Communications]

UDC 621.397.44

[Abstract] The minimum intensity of an image-transmitting radio signal necessary for acceptable quality of its reception in the presence of noise in both video and radio transmission channels is calculated, the signal intensity being measured in  $\mu\text{V}/\text{m}$  and the resultant signal-to-noise ratio serving as indicator of reception quality. Three different variants of a television transmission channel: 1) program generating studio apparatus - radio transmitter - signal propagating medium - individual television receiver; 2) program generating studio apparatus - radio transmitter - signal propagating medium with industrial interference - individual television receiver; 3) program generating studio apparatus - image trunk line - program relaying studio apparatus - radio transmitter - signal propagating medium - individual television receiver. The minimum necessary signal intensity, which obviously increases as the acceptable level of signal reception quality is raised. Calculation of the minimum necessary signal intensity  $E_s$  thus requires evaluation of noise from all influencing sources, then calculation of the signal-to-noise ratios along the channel. Such calculations are made for frequency bands I, II, III, IV-V according to the expression  $E_s = 8^{1/2} \pi N_{gr} N_{tv} V/\lambda m$  times the square root of  $G \eta (N_{gr} N_{tv})$  ( $G$ - receiver antenna gain,  $\lambda$ - average signal wavelength,  $m$ - modulation factor,  $N_{gr}$ - resultant signal-to-noise ratio at radio transmitter output,  $N_{tv}$ - resultant signal-to-noise ratio at image channel output,  $V$ - resultant intensity of receiver, atmospheric, and galactic noise), using a modulation factor  $m = 0.625$  and signal-to-noise values based on CCIR recommendations. Industrial radio interference is found to appreciably lower the reception quality and thus raise the minimum necessary signal intensity, especially in frequency bands I and II. Figures 2; tables 2; references 11.

### Cable and Satellite Television: What Does Soviet Science Offer?

917K0290C Moscow TEKHNIKA KINO I  
*TELEVIDENIYA* in Russian No 3, Mar 91 pp 34-37

[Article by A. Barsukov]

UDC 621.397.743

[Abstract] Achievements of Soviet science contributing to development of cable and satellite television were reported at two recent events, the Second All-Union Scientific and Technical Conference on "Cable Television Systems and Their Maintenance" (USSR Ministry of Communications, All-Union Radio and Television Transmitting Station imeni October Semicentennial) and the Interdepartmental Scientific-Technical Conference on "Problems of and Outlook for Development of

Modern Soviet Television Systems" (All-Union Scientific and Technical Society of Radio Engineering and Electrical Communications imeni A.S. Popov, Suzdal 23-27 December 1990). These achievements include cables for cable television in the USSR, series 300 apparatus for television distribution networks, passive elements for fiber-optic transmission systems, design of cable television systems with fiber-optic communication lines, use of digital fiber-optic transmission systems for multiprogram cable television, and computer-aided design of cable television systems using such applied program packages as DRS, SKTW, NETWORK. Another project underway is a multifunctional fiber-optic switched information televising system, access to a bilateral digital 144 kbit/s channel of the Integrated Subscriber Dialing Network as well as to one or two of 16 switched television channels and to one or several stereo sound channels being considered in the first stage of its development. Tables 2.

### **Cable Television: How To Expand Broadcasting (Project of International Television Development Bank)**

*917K0290D Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 3, Mar 91 pp 40-42*

UDC 654.197.2

[Abstract] Expansion of cable television, a project of the International Television Development Bank, is examined from the Soviet perspective and with reference to the American model of commercial television. Legal as well as commercial aspects of establishment of export-import relations with European and American film producers are discussed, two specific problems to be considered in any new project being viewers' preferences and copyright laws.

### **Features of Modern Television Character Generators**

*917K0290E Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 3, Mar 91 pp 43-46*

[Article by V. V. Bykov, All-Union Scientific Institute of Television and Radio Broadcasting

UDC 621.397.43.006:681.327.01

[Abstract] The state of the art in television character generators is reviewed, either of two basic principles being used for their synthesis: matrix graphics ("Aston 4", "Caption") and vector graphics ("Delta 1" by Quanta). The matrix graphics technique involves allocating in the memory a rectangular matrix a certain number of its square cells for each sign, display in colors requiring a ternary matrix structure with a 3-bit "depth" for reproduction of eight

colors or with 24-bit structure (8 bits per color component) for reproducing all  $16.8 \times 10^6$  colors. The vector graphics technique involves formation of each sign with horizontal straight line segments in later generator models also arcs for rounding the corners, their thickness being equal to the thickness of a scanning line and their lengths and locations being determined mathematically. The basic structure of a television character generator consists of a terminal with keyboard, a control unit, a text random-access memory, a type read-only memory, a switch-mixer stage, and a magnetic disk storage. Since a character generator forms a discretized wideband signal without preliminary low-frequency filtration, oblique straight line segments and also arcs will be serrated. This saw-tooth effect and the flicker of plane horizontal sign edges, both effects characteristic of digital signal generators, can be minimized: the saw-tooth effect by digital filtration and the flicker effect by making the narrow horizontal bars occupy an even number of scanning lines so that they occupy the same number in each of the two fields. Digital processing shapes a signal, as does a television camera, so that sign edges are quantized not into two binary levels "0" and "1" but into eight or more levels and the thus created gray intermediate zones improve the image quality. Digital processing gives, however, rise to problems associated with sign and background chromaticity, these problems having been successfully solved by various manufacturers. Modern television character generators must ensure high resolution and typographic excellence of text display. They must be able to generate characters not only in the various conventional types but also be adaptable to user's modification of those types and invention of new ones. Other required features are polychromaticity with a flexibility allowing the color of each sign to be individually changed. There must also be flexibility to allow use of several different types on the same page and even in the same line and flexibility to allow various modes of text display. It must, furthermore, be possible to form a text in several independent planes with one plane given priority over another. There must be facilities included for editing and for addition of subtitles during simultaneous operation with a magnetic sound recorder in the address-time code. While text resolution and functional capabilities are the usual criteria for a comparative evaluation of television character generators available on the market, it has now become necessary to also consider their compatibility with CCIR Recommendation 601 that elements of the sign image correspond to an element of 74 ns duration in digital television systems. Figures 3; references 11.

### **UHF-VHF FM Receiver**

*917K0313A Moscow RADIO in Russian No 3, Mar 91 pp 22-25*

[Article by Ye. Frolov (UA3ICO), V. Dolomanov (UA3IBT), N. Berezkin (UA3JD), Tver]

[Abstract] Increased interest in operation in the UHF-VHF (UKV) band using frequency modulation (ChM)

and the need to promote FM ham radio and organize UHF-VHF FM ham networks are identified. An easy to duplicate design of a superheterodyne receiver with single frequency conversion developed by the authors is described. The receiver is intended for use as standby and monitoring equipment for receiving urgent, technical, and sports information and monitoring sporadic radio wave propagation as well as receiving digital data on an experimental basis. The receiver operates in the 145.4-145.7 MHz band and has a 5  $\mu$ V sensitivity. Its intermediate frequency (PCh) is 6.5 MHz, IF bandwidth is 50 kHz, and RF bandwidth is 300 kHz. The receiver design is based on a series K174 integrated circuit, UPChZ-1M television module which contains a K174UR4 integrated circuit, and filters. Its input resistance is 75  $\Omega$  and it has a power output of 50 mA. The receiver is fine-tuned with an external 75  $\Omega$  antenna when working with ham radio. Using a whip antenna, the authors used the receiver to monitor the operation of many UHF-VHF FM ham stations in Tver [formerly Kalinin]. References 7; figures 5.

#### New Commercial SECAM-PAL Decoders

917K0313B Moscow RADIO in Russian No 3,  
Mar 91 pp 36-40

[Article by L. Kevesh, A. Peskin, Moscow]

[Abstract] The new commercial SECAM-PAL decoders developed by the design office of the Rubin production association for use in mixed "Rubin" TV sets containing MTs-402 and MTs-403 chromaticity modules and PK-402 and PK-403 picture tube boards, respectively are described and their general view and block diagram are presented. The principal specifications of the MTs-402 module which is intended for processing chroma signals in the SECAM and PAL standards with automatic switching from one standard to the other are cited. The MTs-403 module and PK-403 board are modifications of the MTs-402 module and PK-402 board, respectively. The module and board are designed on the basis of the MDA3530 (K174KhA31) and MDA3510 (K174KhA28) integrated circuits, respectively. The operating principle of the decoder and its components is described in detail. References 6; figures 4; tables 1.

#### Additional Decoder in 'Radio-86RK'

917K0313C Moscow RADIO in Russian No 3,  
Mar 91 pp 42-43

[Article by I. Krylova, Moscow]

[Abstract] Limitations of the Radio-86RK ham radio computer whose address space is partitioned into 8 kbyte blocks are discussed and its major shortcomings - address shortage and mutual reprogramming of ports and interval timer counters when the voice synthesizer occupies the same address as the K580IK55 (D14) parallel interface - are identified. It is shown that the voice synthesizer can be "decoupled" from the port thus freeing space for additional peripheral devices by adding to the ham radio computer one more decoder, e.g., K555ID7. The use of this additional decoder makes it possible to set up eight areas with a size from one byte to one kilobyte in any of the 8 kbyte blocks. The design diagram of the additional decoder is cited and its operating principle is described in detail. It is emphasized that the ham radio computer should be expanded very carefully since this increases the load on the address busses and data bus; it is therefore expedient to buffer the busses in order to protect computer serviceability. References 2; figures 1.

#### Use of Series 142, K142, and KR142 Integrated Circuit Regulators

917K0313D Moscow RADIO in Russian No 3,  
Mar 91 pp 47-51

[Article by A. Shcherbina, S. Blagiy, V. Ivanov, Moscow]

[Abstract] The use of integrated circuit voltage regulators and power supply sources on theirs basis is summarized and it is noted that these power supply sources are distinguished by a small number of additional parts, low cost, and good performance. Characteristic features of the use of 142YeN5, 142YeN8, and 142YeN9 voltage regulators which have an identical design and contain a power supply circuit fault protection device are described. The devices differ only in the maximum output current and output voltage rating. The following types of voltage regulators (SN) are described: regulators protected from damage by capacitor discharge current; regulators with discrete voltage outputs; regulators with extra-stable output voltage; regulators with 0-10 V switchable output; regulators with external control transistors; high-power regulators; regulators with a high stabilization factor; regulators with parallel integrated circuits; a bipolar regulator; and regulators with controllable output voltage. References 1; figures 14.

**Matching Parameter Optimization of Finite Phased Arrays**

*917K0310A Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIODELEKTRONIKA*  
*in Russian Vol 34 No 2, Feb 91 pp 4-8*

[Article by K. G. Klimachev]

UDC 621.396.677

[Abstract] The use of matching devices in phased antenna array radiator channels necessitated by the need to manipulate radiation characteristics of multifunction radio complexes' antenna systems due to changes in radiators' input resistance during their operation is considered. An effective algorithm of parametric matching system (SU) synthesis which takes into account the impact of fringe effects on the input resistance of phased antenna arrays (FAR) with a small number of elements is developed. A transmitting phased array each of whose radiator channels contains a matching device representing a multistage impedance transformer is considered. The criterion function is determined and a method of solving the optimization problem is selected. Matching devices with identical and different parameters in radiator channels are used to examine the phased array parameter optimization. Recommendations are made for selecting the initial approximation of the manipulated matching element variables. It is noted that phase array sheet matching is characterized in that the reflectance and, consequently, input resistance of one finite antenna array radiator depends on the wave amplitudes in the remaining reflectors, as a result of which matching elements should be synthesized for a specific type of phased array excitation. References 3; figures 3; tables 1.

**Analysis of Printed Phased Array Crossed-Dipole Radiator Allowing for Structural Elements**

*917K0310B Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIODELEKTRONIKA*  
*in Russian Vol 34 No 2, Feb 91 pp 8-12*

[Article by V. V. Chebyshev]

UDC 621.372.828

[Abstract] The use of dipole radiators in designing large-scale scanned antenna arrays, especially printed radiators which realize the advantages of the printed circuit technology, is considered; in so doing, the effect of additional factors, primarily the stripline dipole structure and the laminated medium of dipole substrates and phased array cover is taken into account. The design of a printed phased antenna array (FAR) radiator dipole is examined allowing for the effect of support posts and pins in the array aperture as well as concentrated dipole loads. The design is based on deriving a system of Fredholm's first-kind integral equations for radiator conductor currents and solving it numerically. An algorithm is developed and the results of a numerical analysis of phased array radiators with an oblique grid are

cited. In particular, a rotary polarization printed dipole radiator is considered and a solution algorithm employing the self-regularization principle is proposed. The phased array radiator element's numerical analysis algorithm was compiled in the FORTRAN language for the BESM-6 mainframe computer (EVM). It is shown that by selecting the substrate and dipole loads it is possible to ensure the use of shortened dipoles in phased arrays and manipulate their scanning sector. References 3; figures 3.

**Radiation Field Energy Spectrum Structure of Active Phased Arrays With Monochromatic Driver Signal**

*917K0310C Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIODELEKTRONIKA*  
*in Russian Vol 34 No 2, Feb 91 pp 21-26*

[Article by V. L. Gostyukhin, V. N. Trusov]

UDC 621.396.677

[Abstract] Intrinsic noise in transmitting phased antenna array elements which contains both amplitude and phase components (i.e., combined noise) and the mostly phase noise contributed by active modules (AM) of active phased antenna arrays (AFAR) which may degrade the phased radio system performance are addressed. The importance of examining spurious emission components of complex antenna systems with amplifiers distributed over the entire aperture, this emission's dependence on orientation in space, and its effect on the total energy spectrum structure is emphasized. For illustration, continuous wave radio systems are examined while it is stressed that pulsed systems may also be used as an example. To this end, the character of spurious active phased array emission in the presence of noise on the active module input is examined. It is shown that a spectral correlation analysis of the problem makes it possible to obtain analytical expressions for the composite energy spectrum components and establish their dependence on spatial coordinates. The results of a numerical analysis are cited. This approach to analyzing active phased arrays makes it possible to estimate the spectrum of the emission field amplitude and phase fluctuations which is necessary for determining the potential and parameters of radio engineering systems for various purposes. References 3; figures 2.

**Approach to Phased Antenna Array Malfunction Diagnostics**

*917K0310D Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIODELEKTRONIKA*  
*in Russian Vol 34 No 2, Feb 91 pp 32-38*

[Article by Ye. V. Voronin, A. Yu. Grinev, M. M. Gorina]

UDC 621.317.743.:621.396.677.4-427.5

[Abstract] Phased antenna array (FAR) performance diagnostics during the operation, an important task of antenna metrology, by means of aperture-probe, switching, modulation, etc. methods of measuring the parameters and monitoring the state of phased arrays based either on direct amplitude or phase metering or indirect analysis of the amplitude-phase current distribution (AFR) in the array is summarized. Methods of reducing the volume of computations by using *a priori* information about the parameters of a serviceable array and formalizing the resulting problem solution in a programmable form are studied. Thus, a computational procedure of indirectly identifying the total number of malfunctioning phase shifters in a transmitting phased antenna array as well as their distribution in subarrays is described. The approach is characterized in that its hardware implementation is simple while computer outlays are reduced. It is demonstrated that the proposed phased antenna array diagnostic method is efficient from the viewpoint of computer time outlays compared to known techniques. A numerical experiment shows that even for a phased array with 1,089 elements and 127 subarrays, IBM PC/XT computer time does not exceed 8 s given a 0.8 Mbyte memory. The technique can be improved with the help of a correcting transparency as well as by properly selecting the number of subarrays. References 5; figures 5.

#### Phased Antenna Arrays and Hybrid Reflector Antennas Adaptive to Eigenstate

917K0310E Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIODELEKTRONIKA in Russian Vol 34 No 2, Feb 91 pp 38-43

[Article by V. I. Gusevskiy, E. I. Lidskiy, S. V. Ryzhkov]

UDC 621.396.494

[Abstract] An attempt is made to outline the range of problems which arise in designing antennae, which are adaptive to their eigenstate, at the stage of their development as well as during their operation due to the fact that individual elements of multielement phased antenna arrays (FAR) and hybrid reflector-type antennas (GZA), i.e., antenna modules, controlled microwave (SVCh) devices, amplifiers, etc., fail during the operation of radio engineering systems containing such antennae. Amplitude-phase distribution (AFR) distortions of the antenna array (AR) aperture field caused by these failures lead to a decrease in the AR gain (KU), an increase in the side lobe level (UBL), and an angular displacement of the radiation pattern's (DN) major lobe. This necessitates an examination of the design of phased arrays and hybrid reflector antennas which are adaptive to their eigenstate, i.e., can self-adapt to failures of their own elements using an automatic monitoring subsystem. It is shown that the functional reliability of these radio systems can be improved considerably by using current monitoring data on the actual state of these antennae

and arrays with the help of special adaptive control algorithms which within set tolerances stabilize the antennae's external parameters, i.e., beam orientation, side lobe level, beam pattern shape, and directive gain (KND). References 5; figures 5; tables 1.

#### Optically Controlled Light Modulator for Antenna Array Signal Processing

917K0310F Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIODELEKTRONIKA in Russian Vol 34 No 2, Feb 91 pp 65-66

[Article by V. S. Temchenko, V. G. Ovchinnikov]

UDC 621.397.193

[Abstract] The development of optoelectronic processors for processing antenna array (AR) signals and the related improvement in their component base, particularly the development of optically controlled space-time light modulators (PVMS) which make it possible to determine the spatial coordinates of entities in real time, extract data on independent spatially separated channels, and perform spatial elimination of noise signals, are addressed. A method of eliminating interfering signals by means of an optically controlled space-time light modulator matched with a cathode ray tube (ELT) is examined experimentally. A block diagram of the linear antenna array processor is cited. The cathode ray tube eliminates the need for using an additional He-Cd laser, imaging system, and deflector for recording the transmission function. The resulting study make it possible to determine the requirements imposed on the parameters of optically controlled space-time light modulators operating as a component of a hybrid optoelectronic processor. References 2; figures 2.

#### Indirect Phased Antenna Array Diagnostics by Switching Method

917K0310G Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIODELEKTRONIKA in Russian Vol 34 No 2, Feb 91 pp 70-72

[Article by Ye. N. Voronin, M. M. Gorina]

UDC 621.317.743:621.396.677.4-427.5

[Abstract] An approach to diagnosing phased antenna arrays (FAR) based on the authors' method whereby an  $N+1$ -dimensional vector-signal is measured in the near-field zone of a multielement phased array at  $N+1$  orthogonal states of binary subarray phasing in an orthogonal basis is proposed. An analysis of the indirect phased array diagnostics method demonstrates that it is efficient in the sense of computer time outlay savings compared to known methods; moreover, it exceeds the diagnostic accuracy by more than twofold compared to an earlier method developed by the authors. It is shown that the method can be further improved by using fast Walsh-Hadamard (UA) algorithms. For certain types of phase

shifters and their malfunctions, this approach does not rule out using fast Fourier transforms (BFP) as well as a combination of fast Fourier transforms and Walsh-Hadamard algorithms at subarray and individual element levels which ensure the highest speed of phased array diagnostics. References 4; figures 1.

### Investigation of Feeds With Anisotropic Coating

917K0310H Kiev IZVESTIYA VYSSHIKH  
UCHEBNYKH ZAVEDENIY: RADIODELEKTRONIKA  
in Russian Vol 34 No 2, Feb 91 pp 78-81

[Article by I. V. Borovskiy, O. G. Gamulya, A. P. Udovenko]

UDC 621.372.8

[Abstract] The low level of cross-polarized radiation (KPI) required of today's reflector antennae in which the antenna feed whose cross-polarized radiation level is, *inter alia*, determined by the absence of axial beam

pattern (DN) symmetry is the main source of this radiation, is addressed. The use of feeds whose beam patterns are formed during the excitation and emission of the hybrid  $HE_{11}$  mode, such as corrugated horns and horns with a dielectric insert or dielectric lining for attaining a beam pattern with low cross-polarized radiation is discussed and their individual parameters are examined. A mathematical model of a horn waveguide feed with impedance-coated internal walls whose aperture is much greater than the wavelength is considered and conditions for the existence of hybrid and ideal modes are examined. The proposed mathematical model is suitable for describing the properties of known types of feeds employing the hybrid balanced mode but new types of feeds with an artificial anisotropic internal wall coating (including magnetodielectric materials) can also be analyzed on its basis. It is shown that artificial anisotropic coats can be used to design feeds which maintain the requisite beam pattern characteristics either in one sufficiently wide frequency band (with a 2.5:1 cutoff frequency ratio) or within several bands with a given operating frequency ratio. References 4: 1 Russian, 3 Western; figures 3.

### Phase Pattern and Phase Center of Linear and Planar Antennae

917K0316A Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 36 No 3, Mar 91 pp 433-441

[Article by V. I. Gusevskiy]

UDC 621.396.67.01

[Abstract] A new technique for analyzing phase patterns suitable for a broad range of linear and planar antennae in the far field region is proposed on the basis of the orthogonal aperture polynomials (AOP) method whereby the amplitude-phase distribution (AFR) in the antennae aperture is defined by functions belonging to the  $L_2$  space. The concept of antenna far field pattern and phase center (FTs) is used in developing various goniometric and ranging systems, e.g., radio interferometers, phase direction-finders, and Doppler radar. Diverse planar aperture configurations are taken into account using appropriate sets of orthonormalized polynomials. In so doing, known conditions which the amplitude-phase distribution must meet to ensure that the antenna has a phase center are substantiated and several typical antenna AFR's are considered. New expressions are derived for analyzing partial phase center coordinates for which the far field region's phase pattern has a minimal slope in the radiation pattern's (DN) major lobe area. The use of this approach for solving certain antenna engineering tasks is illustrated by an analysis of phase center fluctuations of a linear 20-element array (AR) consisting of collinear half-wave dipoles. It is shown that the above results are rather general, are suitable for a broad range of antennae, and can be used for solving many applied antenna engineering tasks. The author is grateful to B.A. Poperechenko for constructive remarks and N.A. Yurkova for help with computations. References 7; figures 4.

### Issues of Superwide-Band Precision Directional Coupler Development

917K0316B Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 36 No 3, Mar 91 pp 454-459

[Article by B. M. Kats, A. I. Larionov, V. P. Meshchanov]

UDC 621.372.8.01

[Abstract] The role of directional couplers, power dividers and adders, phase shifters, and other devices in primary signal processing is addressed. The problems of synthesizing superwide-band directional couplers (NO) which are the most common passive microwave (SVCh) electronics devices used for performing various functions in microwave circuits are considered. In so doing, characteristic features of synthesizing superwide-band

coaxial directional couplers with an improved performance is examined. The coupling area of these directional couplers is realized on the basis of a new type of coupled coaxial transmission lines (LP) which are distinguished by their practical feasibility and convenience of matching them with single coaxial transmission lines. An experimental design of a precision directional couplers with 0.6-1.25 and 1.5-18.0 GHz operating bands is presented and analyzed. It is shown that the coupler can be used in monitoring, testing, and measuring microwave devices. An analysis of directional coupler study results shows that the search for the optimum geometrical configuration of the coupling area is the key stage in the synthesis process. Implementation of a symmetric directional coupler on the basis of the proposed type of coupled coaxial lines made it possible substantially to improve the directional couplers' electric parameters compared to known foreign prototypes thus experimentally corroborating the theoretical conclusion about the advantage of the symmetric directional coupler structure over the asymmetric. References 6: 4 Russian, 2 Western; figures 3.

### Light Diffraction on Almost Standing Ultrasonic Wave

917K0316C Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 36 No 3, Mar 91 pp 460-466

[Article by G. Ye. Zilberman, G. F. Goltvyan'skaya, I. N. Goltvyan'skiy]

UDC 537.874.6:534

[Abstract] A longitudinal light wave propagating along the Y-axis and two transverse sonic waves whose oscillations are parallel to the Z-axis propagating in a solid dielectric whereby the waves themselves propagate in the XOY plane are considered. The product of wave superposition is a standing wave in the OX direction which travels in the OY direction at a certain high phase velocity which may result in a considerable reciprocal effect. It is shown that during the diffraction of light on an almost standing ultrasonic wave, the nonreciprocity parameter is considerably greater than in the case of diffraction on a single running sound wave as a result of which the phase and amplitude nonreciprocity - the ratios of the amplitudes and phases of waves passing through the sound field in two opposite directions, respectively - is also abnormally large. It is shown that on the outlet from the sound field area whose length is determined by the phase nonreciprocity, the amplitude of one wave is greater than that of the other by more than an order of magnitude. References 6; figures 3.

### Optimal Parameter Estimate of Signals Observed Through Stationary Gaussian Noise With Fractional-Rational Energy Spectrum

917K0316D Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 36 No 3, Mar 91 pp 480-489

[Article by M. A. Mironov, V. I. Shvetsov]

UDC 621.391.01

[Abstract] The task of estimating the parameters of signals observed against the background of noise which is typical of primary data processing in radio electronic complexes and other systems for various purposes is analyzed and the general approach to solving the problem of estimating the parameters of signals received through random noise with set statistical characteristics developed by R.L. Stratonovich from the theory of conditional Markov processes is considered. Methods of this theory of conditional Markov processes are used to derive a precise solution of Stratonovich's equation for the *a posteriori* probability density of the parameters to be estimated, and in particular an analytical expression for the likelihood functional. It is shown that for a signal received through stationary Gaussian noise with a fractional-rational energy spectrum, the problem is reduced to identifying the vector of parameters and finding current estimate of the unobserved components of conditionally Gaussian process responsible for forming the observed noise. For illustration, the problem of estimating the parameters of legitimate signal observed through an additive Gaussian process containing standard Gaussian white noise is considered. It is shown that the above technique is suitable in the case where the observation, legitimate signal, and noise are vectoral processes as well as the case where the observation is carried out at discrete time moments. It can also be successfully applied in the case where the vectoral parameter assumes a finite set of values alternating either at deterministic or random time moments. References 18; figures 1.

#### Unimodal Self-Excited Oscillation Stability in Synchronous Mode-Locked Gyrotron

917K0316E Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian Vol 36 No 3,  
Mar 91 pp 512-520

[Article by M. Yu. Glyavin, G. S. Nusinovich]

UDC 621.385.6.9

[Abstract] Conditions necessary for the development of synchronous mode interaction in the cyclotron resonance band of gyrotrons with large-diameter resonators are examined and it is shown that, e.g., whispering gallery modes which differ only in their azimuthal indices meet these conditions. In the framework of analyzing synchronous mode interaction, the problem of stability of unimodal oscillations is considered. The generating mode is assumed to be central, making it possible to reduce the problem to analyzing the stability of its self-excited oscillations to the excitation of satellite modes which meet the above conditions and are symmetrically positioned relative to their frequencies. In so doing, a traditional axisymmetric gyrotron model is considered in a kinematic approximation on the assumption that the spread of velocities and radii of the electrons' driving centers in a thin tubular beam and space

charge fields can be ignored. A self-consistent set of equations describing the excitation of a random number of modes in the major cyclotron resonance by the electron beam moving in the multimode resonator field is derived and analyzed. The resulting analytical data make it possible to estimate the spectrum density of locked modes whereby high efficiency unimodal oscillations become unstable. It is shown that stable high-efficiency (KPD) excitation on whispering gallery modes can be realized rather easily with up to 30 modes. The authors are grateful to O.V. Dumbrays and M.A. Moiseyev for stimulating discussions. References 12: 11 Russian, 1 Western; figures 4.

#### Electronic Noise Suppression in O-Type Traveling Wave Tubes

917K0316F Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian Vol 36 No 3,  
Mar 91 pp 528-533

[Article by A. G. Lazerson, M. Z. Shlyakhter]

UDC 621.385.6.01

[Abstract] The task of lowering the traveling wave tube (LBV) intrinsic noise dictated by the requirements imposed on amplifiers from the viewpoint of improving the signal quality and decreasing the out-of-band emission, which poses a special problem for powerful O-type traveling wave tubes (LBVO) with a greater than octave operating band due to both high gain at the operating band center and the great width of the amplified frequency band, is addressed. The possibility of decreasing both the spectral noise density (SPMSH) and integral noise power on the tube output by using the properties of the electron current interacting with the electromagnetic wave is analyzed. The proposed approach is based on differentiating the amplification mechanisms of (low amplitude) electron current noise and legitimate signal which is being amplified in a nonlinear mode. To this end, electron current noise amplification in the O-type traveling wave tube with a jump-like interaction parameter change along the beam length. An examination of wide-band noise determined by stochastic current and electron velocity modulation on the tube input shows that it is possible to suppress electron current noise while effectively amplifying the legitimate signal. It is shown that TWT intrinsic noise can also be lowered using slow-wave structures (ZS) in the interaction space. References 7; figures 4.

#### On Ultimate Submillimeter Band Schottky Barrier Detector Speed

917K0316G Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian Vol 36 No 3,  
Mar 91 pp 563-577

[Article by N. A. Mordovets, A. Ya. Shulman]

UDC 621.382.22

[Abstract] The advantages of Schottky barrier structures, such as their high response speed and considerable nonlinearity, which are responsible for their extensive applications in semiconductor electronics as well as their use as detectors and mixers in the millimeter band are summarized and problems of extending their applications to higher frequencies are addressed. It is shown that for some applications, e.g., developing Schottky barrier diodes (DBSh) for shorter wave radiation detection, manifestation of the lag inherent in all surface-barrier structures related to the finite depletion layer carrier transit velocity, is posing a practical problem. The response of Schottky barrier diodes to radiation in the 1 mm to 70  $\mu$ m wavelength band is examined experimentally and it is shown that the response drop at higher frequencies is determined by the earlier predicted delay mechanism which is manifested during the ballistic carrier transport across the depletion Schottky barrier layer. Experimental data and their comparison to the kinetic Schottky barrier diode response theory make it possible to attribute the frequency dependence of the diodes' rectifying properties to a settling delay of carrier distribution in the depletion layer. A numerical analysis demonstrates that the ultimate frequency of Schottky barrier diodes on the basis of n-GaAs may reach 1 THz for efficiently selected parameters. The authors are grateful to I.N. Kotelnikov for constructive discussions, Ye.O. Yunevich for making the Schottky barrier diode, and V.Ye. Lyubchenko for supporting the effort. References 16: 5 Russian, 11 Western; figures 10.

#### Electrostatic Systems for Correcting Image Curvature

917K0316H Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian Vol 36 No 3,  
Mar 91 pp 577-581

[Article by L. A. Baranova, R. A. Bublyayev, S. Ya. Yavor]

UDC 537.533.2

[Abstract] Image correction, particularly image curvature in cathode ray tubes as well as energy and mass spectrometers, with the help of sextupoles or six-electrode element and the shortcomings of such image correction systems, e.g., the difficulty of assembling and aligning them and the high dimensional accuracy of systems necessary to insure a good picture quality, are addressed. Sextupole systems made from three or four planar, e.g., triangular, electrodes with holes having three symmetry planes are examined experimentally and their operation is compared to that of a conventional six-terminal networks. The study was carried out in an optoelectronic bench whereby a three-electrode crossed lens which formed a linear image on the screen was placed between the electron gun and the sextupole. The experiments demonstrate that in their strength, three- and four-electrode six-terminal networks with identically oriented triangular holes are vastly inferior to a

salient-pole sextupole and that a four-electrode six-terminal network whose middle electrodes rotated by 180° is close in power to the salient-pole system but is much easier to make. References 3; figures 4.

#### SHF Wave EM-Field Indication by Fiber Optic Optoelectric Sensor

917K0316I Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian Vol 36 No 3,  
Mar 91 pp 590-594

[Article by V. K. Gorchakov, V. V. Kutsayenko, V. T. Potapov, S. G. Chigarev]

UDC 621.376.2

[Abstract] Optoelectric sensors (EO) employing Pockels's effect - a new means of measuring the electromagnetic wave energy in high-power microwave (SVCh) electronics - are considered. A fiber optic optoelectric sensor in which optical emission is transmitted over optical fibers whereby microwave power is lower than that described by Arakelov et al in ZhTF Vol. 55 No. 10, 1985, by an order of magnitude is presented. The sensor is made from a crystal with a BSO sillenite structure whose advantages over potassium hydrophosphate or lithium tantalate are due to its cubic structure, especially its isotropic dielectric permittivity. The results of an experimental study of a new Pockels-effect based optical sensor for measuring microwave field parameters in a 36.6 GHz waveguide at an up to 8 kW microwave power level are cited and it is demonstrated that the sensor is capable of taking absolute power measurements of the microwave field and visualizing the microwave pulse envelope. It is shown that the light modulation depth depends linearly on the SHF wave power and that the experimental modulation depth is consistent with theoretical estimates. The sensor has functionally duplicated a microwave measuring system consisting of a power meter and a semiconductor detector with a directional coupler and an attenuator. References 5: 2 Russian, 3 Western; figures 3.

#### Semenov and Kalman Filter Covariance Estimation Function

917K0308A Moscow RADIOTEKHNIKA in Russian  
No 3, Mar 91 pp 3-5

[Article by L. S. Vilenchik, A. N. Katulev, M. F. Malevinskii]

UDC 62-50

[Abstract] Kalman filters used for optimal estimates of the phase state of dynamic systems while simultaneously calculating their correlation moments and their shortcomings are discussed. An attempt is made to develop a

method of calculating the Kalman filter covariance estimate function simultaneously with computing the estimates. The development of the method is based on the principle of equivalent substitution of Kalman's filter with Semenov's filter which belongs the class of finite memory filters which, like Kalman's filters, are based on the criterion of the minimum conversion error variance given the same *a priori* information about the statistical characteristics of the input signal. A recurrent Kalman filter equation is derived from the Semenov filter equation. The use of the resulting equations is illustrated by a unidimensional Semenov filter; the formulae are realized on a BESM-6 computer (EVM) many times faster than in the case of the statistical testing method for analyzing the Kalman filter covariance estimate function. The resulting expressions are original and represent the development of earlier approaches to calculating correlation estimate moments of Kalman and Semenov filters. References 6.

#### Synthetic Aperture Radar Input Signal Phase Distortion Estimate

917K0308B Moscow RADIOTEKHNIKA in Russian  
No 3, Mar 91 pp 6-8

[Article by V. I. Priklonskaya]

UDC 621.396.96

[Abstract] The effect of aircraft (LA) flight path instabilities (TN) on the configuration of the synthetic radar (RLS) point target image (RLI) under normal conditions is discussed. An algorithm for simulating phase distortions (FI) of the synthetic aperture radar's (RSA) input signal due to the aircraft flight path instability on the basis of the on-board measurement information for estimating the radar image variations is derived. The synthetic radar signal phase is proportionate to the range and inversely proportionate to the wavelength. It is shown that in simulating the phase distortions caused by the aircraft flight path instability on the basis of airborne data, it is necessary to take into account partial flight path instability compensation in the synthetic aperture radar processing system. The proposed simulation algorithm makes it possible not only to estimate the degree and character of the effect of aircraft flight path instabilities on the radar image of point targets and identify the most significant flight path instability components but also to make recommendations for selecting the aperture synthesis moments and flight path instability equalization parameters. References 6; figures 3.

#### Timing of Digital Sound Signal Coding in Spectral Region

917K0308C Moscow RADIOTEKHNIKA in Russian  
No 3, Mar 91 pp 38-39

[Article by V. A. Suchilin]

UDC 621.372.542

[Abstract] Spectral shape coding of sound signals in order to decrease their redundancy and ways of eliminating sampling discontinuity by smoothing the signal with the help of Tukey's window functions is analyzed. It is shown that this method has a drawback - the use of the window in coding is correct only if samples overlap - which leads to an increase in the coded signal redundancy. A timing procedure is proposed, making it possible to avoid the *a priori* sample overlapping during the signal coding in the domain of spectrum and the related increase in redundancy. The procedure's efficiency is confirmed by the results of half-scale simulation of signals in the audio frequency band. The estimation criterion used in the experimental verification of the timing procedure represents the components of a discrete Fourier transform of the sample normalized by the signal energy over the conversion interval. References 4: 3 Russian, 1 Western.

#### Analysis of Electromagnetic Field Penetration Through Rectangular Slot in Planar Screen in Resonance Frequency Region

917K0308D Moscow RADIOTEKHNIKA in Russian  
No 3, Mar 91 pp 57-61

[Article by G. V. Starkov, S. M. Apollonskiy]

UDC 621.396.67

[Abstract] The dependence of electromagnetic solid shell shielding efficiency on man-made irregularities, such as entrances, ventilation ducts, etc., which are usually simulated by a rectangular slot or broken combination of slots in calculations is summarized. A method is developed for calculating the intensity of electromagnetic field passing through a rectangular slot in a planar shield in the resonance frequency band. The problem is formulated as a monochromatic planar wave of given electric and magnetic intensity propagating in a uniform isotropic air medium which is incident upon an infinite planar electrically thin superconducting screen with a rectangular slot. Assuming that the slot length is much greater than its width, Maxwell's equations are reduced to an integrodifferential equation which satisfies the continuity condition of electromagnetic field functions on an opening with a random shape in an electrically thin planar screen. The solution method is presented and calculation results are cited and compared to the results obtained using a piecewise-linear basis. The resulting technique based on the equivalence principle and moments method makes it possible to simplify the calculation of the electromagnetic field seeping through a slot in the screen and obtain highly accurate results given a relative slot width of  $\leq 0.1$ . The method may be recommended for solving electromagnetic screening problems allowing for the effect of slotted irregularities. References 7: 6 Russian, 1 Western; figures 5.

**Single-Electron Current Pulse Recording Methods**

917K0308E Moscow RADIOTEKHNIKA in Russian  
No 3, Mar 91 pp 75-81

[Article by K. Ye. Rumyantsev]

UDC 621.383.(088.8)

[Abstract] The use of photoelectron or photon counters for measuring the mean intensity of weak luminous fluxes and their limitations are discussed. Existing counting methods are analyzed with respect to equipment for searching for optical radiation sources in information systems where the counting time is limited while the input rate of signal and phonon photoelectrons greatly exceeds the input rate of the dark current's single-electron pulses (OI) and the photodetector channel bandwidth is limited. A light field recording method is considered and photoelectron counters with multichannel amplitude selection are analyzed. It is shown that a light signal recorder using the amplitude-time selection of superimposed single-electron pulses makes it possible to lower the photodetector channel bandwidth requirement by ten- to twentyfold compared to recorders employing single-threshold amplitude discrimination; moreover, a transition from a single- to double-threshold amplitude discrimination makes it possible to narrow the necessary photodetector channel bandwidth from 200 to 22 MHz while in the case of three-channel amplitude selection - to 13 MHz. References 8; figures 4; tables 2.

**Two-Channel Fiber Optic Infrared Radiometer With Semiconductor Modulator**

917K0305A Moscow IZMERITELNAYA TEKHNIKA in Russian No 3, Mar 91 pp 9-11

[Article by Ye. S. Avdoshin]

UDC 535.214.4.082.5

[Abstract] Fiber optic radiometers used to monitor infrared radiation are summarized; it is shown that two-channel infrared radiometers with solid state semiconductor modulators whose operating principle is based on using the phenomenon of optical radiation absorption by free charge carriers in a germanium crystal with a *p-n*-junction are the most promising for this purpose. The relative spectral absorption response of germanium, optical emission of the laser photodiode, pyroelectric detector sensitivity, and fluorite transmission curves are presented. The design of a two-channel fiber optic infrared differential radiometer containing a flexible two-layer optical fiber with an 800  $\mu\text{m}$  diameter made from a silver halide core and a 20  $\mu\text{m}$  silver halide cladding with a 2-15  $\mu\text{m}$  transmission band is described. The radiometer has a measurement channel and a reference channel which receives radiation from a reference source. The radiometer was calibrated using a perfect radiator (AChT) model made as a heating furnace with

two coaxial ceramic tubes and a N-Cr alloy winding on the outer surface. The experiment reveals that the radiometer's output signal varies within 0-100 mV given AChT temperature variations within 293-493K. The output amplitude response was flat within 0.5 percent when the optical fiber face was placed at a 3-6 cm distance from the AChT. It is demonstrated that the radiometer performance and its design simplicity make it possible to use fiber optic infrared radiometers with semiconductor modulators in various optoelectronic monitoring, control, and communication systems. References 12: 11 Russian, 1 Western; figures 2.

**Estimating Longitudinal Object Dimension Measurement Accuracy Using Numerical Coherent Pulse Transmitter Analysis Methods**

917K0305B Moscow IZMERITELNAYA TEKHNIKA in Russian No 3, Mar 91 pp 12-14

[Article by T. M. Volosatova, M. V. Filippov]

UDC 531.71.088.6:621.375.001.24

[Abstract] The use of laser range finders in which master oscillator and amplifier-based multistage pulse systems are used as the transmitter is summarized and the need to develop a method of designing multistage pulse transmitters which takes into account the pulse duration, shape, and power on their output in order to increase the measurement accuracy of longitudinal dimensions of targets is identified. Versatile numerical methods of designing multistage amplifiers are developed and the applicability of each method is estimated. The applicability criterion is defined as the pulse duration being much greater than  $1/\Delta\nu$  where  $\Delta\nu$  is the luminescence line width. In examining the amplification of short pulse, the effect of spontaneous emission and pumping on the pulse transmission time in the amplifier is ignored and it is assumed that these factors determine only the initial inverted population level. The proposed methods are universal for analyzing both three- (ruby) and four-level (garnet and glass) systems. It is shown that the above numerical modeling methods make it possible to obtain the dependence of the pulse duration on the transmitter output signal power in various pumping modes. An analysis of the resulting relationships made it possible to optimize the values of the transmitter's output signal power. References 7:6 Russian, 1 Western.

**Resistance Strain Gauge Calibration Testing Standards**

917K0305C Moscow IZMERITELNAYA TEKHNIKA in Russian No 3, Mar 91 pp 14-16

[Article by M. M. Lupinskiy, G. V. Vasiliadi, B. V. Gumennyuk, V. L. Korolev, V. A. Kryukov, A. V. Retivov, V. M. Fildshteyn]

UDC 531.781.2.089.6

[Abstract] Various standards and regulations governing resistance strain gauges (TR) and their metrological characteristics (MKh) as well as the use of measurement standards (OSI) are summarized. A new TENZO-TEST complex which contains measurement standards, calibration units, and auxiliary devices necessary for the calibration testing of resistance strain gauges according to GOST 21615—76 is described. The complex is based on a UVID unit intended for reproducing and measuring strain under normal conditions making it possible to determine the transfer function, sensitivity, mechanical hysteresis, and creep of resistance strain gauges. The design of the UVID unit and its operating principle and characteristics are described in detail; in addition, the design and operating principle of the UT-600 temperature and strain reproducing and measurement unit and UNT low-temperature unit are described. All three units are capable of being operated automatically or manually. Unit control and measurement systems have a universal output making it possible to interface them with various types of microcomputers. The metrological characteristics of the above standards fully meet the requirements imposed on devices for the calibration testing of resistance strain gauges according to domestic and foreign regulations; all devices employ innovative and ergonomic designs. The devices may be used in research and testing labs, metrological service labs, and at various enterprises and organizations. Their implementation will help to improve the metrological support for the development, production, and operation of resistance strain gauges. References 10; figures 3.

### Digital Phase Meter

917K0305D Moscow IZMERITELNAYA TEKHNIKA  
in Russian No 3, Mar 91 pp 31-33

[Article by A. A. Ishutin]

UDC 621.317.77.083.92

[Abstract] A digital phase meter designed on the basis of a method of converting the phase shift into a time interval used in USSR patents 1538145 and 1092427 is described; the phase meter operates stably with amplitude and phase fluctuation of input signals and jump-like phase increments within the entire phase cycle and has no dead zone. Depending on the component base, its response speed reaches 0.1  $\mu$ s, its frequency band may be expanded to several dozen megahertz, and its phase measurement accuracy does not exceed  $\pm 3^\circ$ . When the phase meter's input signal frequency changes considerably during the measurements, the phase measurement error does not rise significantly. The phase meter design diagram is cited and its advantages over the above designs are outlined. The phase meter employs 1108PV1 or 572PV3 analog-to-digital converters (ATsP) which compute the ratios of the output phase detector (FD) voltage and convert the resulting data in a ROM (PZU) on whose output a code corresponding to the phase shift is formed. Preference in the phase meter

design is given to balanced phase detectors over ring detectors. It is shown that the phase meter can be used in the case where the input signal frequency changes within a broad range during the measurements. References 4; figures 2; tables 1.

### Topological Method of Designing Frequency Transducers' Magnetic Systems

917K0305E Moscow IZMERITELNAYA TEKHNIKA  
in Russian No 3, Mar 91 pp 33-35

[Article by E. G. Ismiyev]

UDC 538.26:513.833

[Abstract] Classical methods of designing magnetic circuits of automatic devices and their shortcomings are summarized and the need to improve the computational design methods and particularly mathematical models of magnetic systems is identified. A topological method of designing the magnetic system of a frequency transducer by representing it as a topological model with a set of graph nodes and arcs is considered and an algorithm for constructing the topological model of the transducer's magnetic system is presented. The values of the magnetic system's electric parameters are calculated. It is noted that the proposed topological approach simplifies the analysis of magnetic systems of frequency transducers while ensuring an adequate calculation accuracy for practical purposes and graphically illustrating the magnetic flux distribution; moreover, the algorithmic notation facilitates computer (EVM) calculations. References 4: 3 Russian, 1 Western; figures 2; tables 2.

### Certification of Waveguide Measures of Millimeter Band Spectral Noise Power Density

917K0305F Moscow IZMERITELNAYA TEKHNIKA  
in Russian No 3, Mar 91 pp 40-41

[Article by O. G. Petrosyan]

UDC 621.517.317.34.089

[Abstract] Waveguide measures of spectral noise power density (SPMSH) necessary for determining the noise performance of dual-purpose receiving and transmitting devices and primary state standards which govern SPMSH's in the 0.002-37.2 GHz band are summarized. The element-by-element waveguide noise generator (GSh) certification method which amounts to experimentally measuring the attenuation factor and temperature in the waveguide channel between the load and the output flange and subsequently processing the resulting data and incorporating them in formulae for computing the SPMSH or equivalent noise temperature is considered. Components of the element-by-element certification method errors related to measurements of the waveguide attenuation factor in millimeter band waveguide channels are analyzed. The methods and

equipment for measuring the waveguide attenuation factor and certifying waveguide noise generators within the necessary accuracy are described and factors which limit the certification accuracy are outlined; it is assumed that in the measurement circuit losses are identical in all junctions. The results of attenuation factor measurements in all waveguide channels within a 37.1-178 GHz band and waveguide noise generator certification are summarized graphically. It is shown that systematic errors in all waveguide noise generators are due to load temperature measurements in the waveguide channel and the environment. It is noted that some waveguide channel are made from nickel and some - from copper. References 8; figures 2; tables 1.

#### **Examination of Electromagnetic Field Distribution of Variable-Inductance RF Pickup Inside Biological Object Model**

917K0305G Moscow IZMERITELNAYA TEKHNIKA  
in Russian No 3, Mar 91 pp 49-51

[Article by L. A. Zinovyeva, A. I. Zinovyev]

UDC 621.372.632:621.8.038

[Abstract] The character of electromagnetic field distribution of a radio-frequency (RF) variable-inductance pickup (VChP) in the axial and radial direction inside a model of a biological entity represented as an infinite semiconductor half-space with the parameters of fatty and muscle tissue or blood is determined in order to ascertain the degree of blood-filling of biological tissue at various depths. The variable-inductance RF pickup is executed as an inductance coil with a small cross section placed above the biological entity model. To study magnetic fields of the variable-inductance RF pickup located above the semiconductor half-space, the nondimensional complex cofactor is determined after which improper integrals containing the product of Bessel's function and a nonlinear function are calculated. The values of the complex cofactor were tabulated using a computer (EVM). The character of the dependence of the vector potential modulus of the field created by the VChP on the normalized polar coordinate is summarized. The penetration depth of the electromagnetic field created by the inductive VChP into the muscle tissue is equal to 0.6 of the inductance coil radius. References 10; figures 2; tables 3.

#### **Approximation of Signal Reflected by Moving Surface**

917K0294A Moscow RADIOTEKHNIKA in Russian  
No 2, Feb 91 pp 26-29

[Article by A. A. Lavrov]

UDC 621.391.833

[Abstract] Processing of an echo signal from a moving target surface by a pulsed Doppler radar receiver with

synthesized aperture on a rectilinearly moving carrier is considered, the signal being a function of space coordinates and of time. An algorithm of surface discretization into an array of point reflectors equidistant in the frequency domain is constructed which will yield the optimum discrete approximation of the signal reflected by the real surface. The algorithm involves calculating the space-time frequency spectrum of the signal, namely evaluating a bilaterally infinite double integral which represents the convolution of the signal spectrum from a point target by an appropriate generating function. The latter becomes the linear mass when the distance resolution element is sufficiently small and  $x_d(x,y) = x_d(x)$  ( $x_d$ -shift of image of moving point reflector in synthesized antenna aperture). The accuracy of this approximation is shown to be determined principally by the ratio of the mean-square deviation of the random component of the velocity distribution component to the velocity resolution of the radar and that the mean-square distance error does not depend on the signal approximation parameters, most importantly on the time discretization interval. Such an approximation of an echo signal is thus not feasible when the mean-square deviation of velocity shifts is comparable with or larger than the time resolution of the radar. Figures 3; references 3.

#### **Efficiency of Optimum Rank-Testing Detector of Signals in Small Samples**

917K0294B Moscow RADIOTEKHNIKA in Russian  
No 2, Feb 91 pp 29-31

[Article by A. M. Brinker and T. Ye. Martynova]

UDC 621.391

[Abstract] The performance of an optimum rank-testing detector of signals in samples of limited size is analyzed and its inefficiency in terms of false-alarm probability is shown to increase appreciably, relative to that of all other optimum detectors, with decreasing sample size. This is demonstrated on two examples, the first one being a sample of five strobe pulses possibly containing a signal  $s = [-2, -1, 0, 1, 2]$  in the presence of an additive Gaussian noise with zero mean and unity dispersion. The second example is a sample with a Rice density distribution possibly containing a unipolar signal  $s = [1, 2, 3, 4, 5]$  in the presence of a one-dimensional Rayleigh noise. At the same time, however, such a nonparametric detector is also found to feature a high stability and an insensitivity to monotonic nonlinear zero-lag conversions of the input process even when the sample size is small. Figures 5; references 5.

#### **Analytical Model of Digital Carrier Propagating Along Earth Surface**

917K0294C Moscow RADIOTEKHNIKA in Russian  
No 2, Feb 91 pp 32-36

[Article by M. I. Gavrilov and Yu. F. Uryadnikov]

UDC 538.3

[Abstract] Use of binary code sequences based on Walsh functions as digital carriers of surface radio transmission lines formed by vertical dipoles is considered, such digital carriers being technologically most readily realizable. Considering further that use of digital carriers involves operation with transient electromagnetic fields, the properties of Walsh carriers at the termination of such a radio transmission line are analyzed for their dependence on the parameters of that line. According to the King-Brown definition (I.E.E.E. TRANSACTIONS Vol 72 No 5, 1984), the transfer function of a surface radio transmission line involves the corner frequency between the intermediate range from the asymptotic range, as output at the termination of the line being simply regarded the vertical component of the electromagnetic field intensity at the reception point. The results of an analysis, using the inverse Laplace transform of that transfer function and involving the theory of propagation of electromagnetic side waves, indicate that the magnitude of intersymbol distortions in the signal depends on both the clock frequency of the Walsh function and on the distance from the transmitter. Numerical calculations confirm that it increases with either higher clock frequency of the Walsh function, a higher clock frequency being desirable for higher data transmission rate, and with farther distance from the transmitter. They also indicate that the accuracy of this model is adequate for engineering purposes. Figures 6; references 3.

#### Determination of Interval Between Shifts in M-Sequence

917K0294D Moscow RADIOTEKHNIKA in Russian  
No 2, Feb 91 pp 43-45

[Article by V. A. Andropov]

UDC 621.391

[Abstract] A method of determining the interval, i.e., the number of clock shifts "l" between two cyclic shifts in M-sequences is proposed which does not involve sorting in a  $GF(2^m)$  Galois field extension, assuming given initial shift of blocks  $n(l) = (s_{l-m+1}, \dots, s_l)$  ( $m$ - memory of M-sequence). The method is based on the relation between the value of an arbitrary symbol in a linear recurrent sequence and the values of  $m$  preceding successive symbols. From the given initial combinations  $n(p) = (s_{p-m+1}, \dots, s_p)$  and  $n(j) = (s_{j-m+1}, \dots, s_j)$  are, according to Yarmolik's algorithm (V.N. Yarmolik, RADIOTEKHNIKA No 6, 1986), determined first the two vectors of coefficients  $\delta(p), \delta(j)$ . Next are calculated  $p$  and  $j$ , which then yield the difference  $p-j$ . The method is demonstrated on an M-sequence generated by the polynomial  $h(x) = x^3 + x + 1$ , with given initial combinations  $n(p) = (101)$  and  $n(j) = (111)$ . References 6.

#### Synthesis of Optimum Algorithm for Space-and-Polarization Diversity Processing

917K0294E Moscow RADIOTEKHNIKA in Russian  
No 2, Feb 91 pp 45-48

[Article by Buhali Salem]

UDC 621.396.24

[Abstract] An optimum algorithm of nonlinear discrete filtration is constructed for processing space-and-polarization diverse signals, to ensure reliable far-range probing the ionosphere with decametric radio waves inevitably subject to deep fadeouts which vary in time. The algorithm is designed for a receiver antenna system consisting of two arrays polarized in mutually orthogonal directions, with arbitrary linear, circular, or elliptic  $[gy, \eta]$  unit vectors each. The algorithm is based on concurrent nonlinear filtration of discretely-continuous Markov processes (V.I. Tikhonov, V.A. Smirnov, and V.N. Kharisov, RADIOTEKHNIKA I ELEKTRONIKA Vol 23, 1978). It facilitates separate filtration of the a'priori independent vector of continuous signal parameters and vector of radio-channel quadrature transmission coefficients for differently polarized electromagnetic field components, which appreciably reduces the number of equations to be solved. The processor for execution of this algorithm includes accordingly a filter of continuous signal parameters and a set of weighting modules which estimate the quadrature coefficients, followed by a discrete-data extractor which adds the output signals of all weighting modules and produces an optimum estimate of the transmitted discrete-data symbol according to the maximum a'posteriori likelihood criterion. The processor also includes a generator of reference signals. Figures 1; references 7.

#### Determination of Trajectory of Phase Center of Scanning-Antenna Exciter

917K0294G Moscow RADIOTEKHNIKA in Russian  
No 2, Feb 91 pp 58-60

[Article by A. I. Shalyakin]

UDC 621.396.677.83

[Abstract] A scanning antenna with an exciter consisting of a horn and a plane auxiliary reflector is considered, oscillation of the antenna beam being effected by transverse movement of the phase center of the exciter. A method of measuring the trajectory of that phase center and a special test stand for it are proposed which avoid unwieldy phase measurements and eliminate the need of a computer for data processing. The test stand consists of a VSWR meter and a spherical reflector, it being necessary to determine the position of this spherical reflector relative to the antenna exciter from which the latter will intercept the largest echo signal and then precisely pinpoint the transverse coordinate of that reflector in this position. Following

this preliminary procedure, the coordinates of the phase center in the transverse plane are plotted as functions of the two voltages  $V_E$  and  $V_H$  controlling oscillation of the plane reflector in the plane of the horn. Such measurements were made with the plane reflector on two mutually orthogonal "spring" mounts one above the other allowing the reflector to rock, each mount resting on elastic supports built into the firm base. The results confirm that increasing the transverse displacement of the phase center at a fixed corresponding control voltages will widen the scan sector in the corresponding plane and that raising a control voltages will increase the transverse displacement of the phase center in the corresponding plane. The latter relation is a nonlinear one with hysteresis, a major drawback of this arrangement. The advantages of using an auxiliary reflector are nevertheless its small size and mass, absence of rubbing parts, and realizability of intricate antenna beam trajectories. Figures 5; references 6.

### Electromagnetic Solitary Waves in Media With Imaginary Conductivity

917K0294H Moscow RADIOTEKHNIKA in Russian  
No 2, Feb 91 pp 72-74

[Annotation of article by N. P. Khvorostenko deposited under No 1726 at the "Informsvyaz" Center for Scientific and Technical Information]

UDC 621.371:539.12.01

[Abstract] The possibility of electromagnetic solitary waves propagating through media with an imaginary conductivity such as a collisionless ionosphere is proved on the basis of a one-to-one correspondence between solutions to the Maxwell field equations and solutions to the Dirac equations for four-component spinor wave functions. Following reduction of the Maxwell equations to a symmetric form by dynamic normalization of both wave functions  $E = (\mu/\epsilon)^{1/4} e^{j\omega t} \Psi_E$  and  $H = (\epsilon\mu)^{1/4} e^{j\omega t} \Psi_H$ , it is demonstrated that every solution to those Dirac equations corresponds one and only one analogous solution to those Maxwell field equations. Since the parameter  $k_0 = 2\pi m_0 c/h$  in the Dirac equations is a real quantity ( $m_0$ - rest mass of Dirac particle,  $h$ - Planck constant,  $c$ - speed of light in vacuum), it is in this way proved that electromagnetic solitary waves with properties of massive charged vector particles can exist in media with a pure imaginary electrical conductivity. The mechanism of their stability can be established by rewriting the Maxwell field equations as second-order equations, one for each component of vectors  $\Psi_E$  and  $\Psi_H$ . The solutions to these equations then show that solitary electromagnetic waves, unlike solitary spinor waves, can exist only at the Landau ground energy level.

### Fiber-Optic Infrared Radiation Recorder With Liquid-Crystal Modulator

917K0294I Moscow RADIOTEKHNIKA in Russian  
No 2, Feb 91 pp 80-83

[Article by Ye. S. Avdoshin]

UDC 536.521

[Abstract] An infrared radiation recorder is described which consists of a 0.5 m long optical fiber with a numerical aperture  $N= 0.66$ , a fiber-optic coupling, a lead-in glass prism and a biconvex short-focus germanium lens, a polarizer, a liquid-crystal modulator, an analyzer, a biconvex short-focus fluorite lens and a lead-out glass prism, a germanium photodiode serving as photodetector, a TsTS-19 (strontium zirconate-titanate) piezoceramic plate with silver contact tabs serving as piezoelectric cell, and a 15 V d.c. voltage supply. The modulator is a 30  $\mu\text{m}$  thick layer of nematic liquid crystals formed by the ZhK-11 mixture (four ingredients), which exists in this state at temperatures from -30°C to 67° with a birefringence  $\Delta n= 0.11$  and a 0.4-3  $\mu\text{m}$  optical transparency window. This layer, together with a 30  $\mu\text{m}$  thick Teflon washer-seal containing it, is placed on a 5 mm thick glass substrate in a rigid mount and covered with a 0.5 mm thick flexible Dacron membrane. The two prisms are made of STK-3 quartz glass, this glass with a 0.4-2  $\mu\text{m}$  transparency window being optically compatible with ZhK-11 liquid crystals. Translucent films of an electrical conductor material are each coated with a 100 nm thick aluminum mirror film and all connected through microconductors to the voltage supply. Application of a voltage ensures, if necessary, orientation of the liquid crystals so that their axes become perpendicular to both the plane of the substrate and the parallel to it plane of the membrane. The optical fiber has a core of  $\text{As}_2\text{Se}_3$  glass 400  $\mu\text{m}$  in diameter with a refractive index  $n= 2.481$  and a coefficient of thermal expansion  $k= 25 \times 10^{-6}/^\circ\text{C}$ . Its sheath of  $\text{As}_2\text{S}_3$  glass has a refractive index  $n= 2.406$  and a coefficient of thermal expansion  $k= 19 \times 10^{-6}/^\circ\text{C}$ . The photodetector has an active surface spot 250  $\mu\text{m}$  in diameter, its quantum efficiency is 60 percent and its absolute sensitivity is 0.75 A/W. The electronics include an operational amplifier followed by a voltage amplifier and a synchronous detector. The latter receives electric input signals from that amplifier and also from an oscillator through a pulse shaper-amplifier, its output signals then passing through a direct-current amplifier to an ammeter. The oscillator sends signals to the synchronous detector and also to an amplifier which controls the piezoelectric cell. The recorder was tested with an InGaAsP/InP semiconductor injection laser operating at the 1.5  $\mu\text{m}$  wavelength with a power of 5 mW. Radiation emitted by this laser was passed through a collimator to the optical fiber, entrance losses being minimized to 1 dB by matching the laser with the polished fiber tip. The membrane was excited into, the exciter being driven by a sound generator and controlling the membrane displacements. The frequency of vibrations was monitored by a frequency meter, their amplitude being measured by a standard piezoelectric transducer mounted on the moving part of the exciter and feeding electric signals to a vibrometer. The amplitude characteristics of the recorder, based on photodiode and vibrometer readings, indicate that a 90 percent modulation factor is attainable with the liquid crystals at -10-(+60)°C temperatures and the membrane vibrating at a frequency of 140 Hz to an amplitude of 0.2  $\mu\text{m}$ . Figures 3; references 11.

**Microprocessor-Based Signaling, Interlocking, and Blocking Device Status Monitoring System**

*917K0299A Moscow AVTOMATIKA,  
TELEMEKHANIKA I SVYAZ in Russian No 2,  
Feb 91 pp 9-11*

[Article by A. V. Andreyevskikh, A. N. Bayduzh, V. T. Domanskiy, I. I. Kinenev, Dnepropetrovsk and Leningrad Railroad Transport Engineers Institutes and Odessa Railroad]

UDC 325.5-181.4:656.25.071.84

[Abstract] The poor professional training of technicians servicing the signaling, interlocking, and blocking (STSb) devices and the resulting need for automatic monitoring of these systems in order to diagnose and forecast the status of STSb devices is discussed. A microprocessor-based device for monitoring the parameters of an all-electric interlocking (ETs) system designed on the basis or an automatic microchip-based voltage regulator and described in ATiS No 7, 1986 is presented. The MPU-AKP-ETs device consists of a controller, a digital instrument, and digital printer, a peripheral interface, and power supply sources; it is capable of monitoring the status of entities with the help of 16 logic and 256 modulating transducers which, in turn, are divided into 16 groups. The controlled entities are cyclically scanned using a standard routine. The operating principle of the device is described in detail and its block-diagram is cited. The microprocessor-based system for monitoring the status of signaling, interlocking, and blocking devices was successfully tested at the Kherson station on the Odessa Railroad and has been in pilot operation since 1990. Figures 1; tables 4.

**Microprocessor-Based Signaling, Interlocking, and Blocking Device Diagnostic System**

*917K0299B Moscow AVTOMATIKA,  
TELEMEKHANIKA I SVYAZ in Russian No 2,  
Feb 91 pp 11-13*

[Article by I. Ye. Dmitriyenko, A. K. Pak, A. V. Punchak, T. Ya. Tikhaya, All-Union Railroad Transport Engineers Correspondence Institute]

UDC 6817325.5-181.4:656.25.071.84

[Abstract] A new signaling, interlocking, and blocking (STSb) device diagnostic system designed on the basis of microprocessor and computer (EVM) technology and the tasks accomplished in developing such a system, i.e., selecting the optimal number of monitored variables which ensures the maximum amount of data on the monitored entity performance and developing hardware for processing diagnostic information with its subsequent analysis and display on a special panel or terminal are addressed. The microprocessor-based Prognoz diagnostic complex intended for monitoring 16 parameters of each signaling, interlocking, and blocking system

element is considered and its block-diagram and operating principle are described. In addition to generating information about the monitored entity, the Prognoz control routine includes maintenance instructions. The STSb diagnostic system design experience shows that high efficiency and good performance may be achieved by expanding its functional capabilities, such as using the continuous information obtained by the system about the current status of STSb device for updating a train situation model. The designers offer their assistance in implementing the microprocessor-based STSb diagnostic system provided that the clients supply their own SM-1800 or SM-1810 computers (EVM). Figures 2.

**Fiber Optic Communication Line Equipment Construction and Assembly in Railroad Transport**

*917K0299C Moscow AVTOMATIKA,  
TELEMEKHANIKA I SVYAZ in Russian No 2,  
Feb 91 pp 24-27*

[Article by V. V. Vinogradov, V. N. Nuprik, Leningrad Railroad Transport Engineers Institute]

UDC 621.315.391.17.6

[Abstract] Recent experience with fiber optic communication line (VOLS) construction and assembly in railroad transport is summarized and recommendations for improving the railroad fiber optic communication line construction and assembly are given on the basis of this experience. In particular, techniques for laying and splicing optical communication cables, methods of assembling and wiring sleeve couplings, procedures involved in building fiber optic communication lines and laying optical communication cables (OKS) in existing cable ducts and asbestos cement or polyethylene tubes as well as reinforced concrete chutes, and emergency and recovery operations are described in detail. The following principal conclusions are drawn on the basis of VOLS construction experience:

1. Management and preparatory measures greatly affect the quality of VOLS construction;
2. Railroad fiber optic cables should be laid in polyethylene tubes;
3. Requirements imposed on the optical cable design should be determined by the laying method as well as assembly and reconstruction and repair technology;
4. Optical fiber welding devices and tool commercially produced today must be upgraded;
5. It is expedient to develop an optical adapter to the R-5 reflectometer.

Figures 7; tables 3.

**Ultra-Short-Wave Radiotelephones Exported to USSR**

91P60227B Beijing ZHONGGUO DIANZI BAO  
[CHINA ELECTRONICS NEWS] in Chinese  
26 Jun 91 p 2

[Article by Ren Guangquan [0117 0342 3123] and Wang Guocai [3769 0948 2088]: "Domestic Communications Equipment Has Great Market Potential in Soviet Union, East Europe; A Discussion of Plant 716's Export of Communications Systems to the USSR"]

[Summary] In March of this year, 150MHz ultra-short-wave three-circuit duplex radiotelephones manufactured by Plant 716 were exported to the USSR, and Chinese engineers were dispatched to install and debug the equipment and to assist authorities in a Ukrainian city in setting up a regional wireless communications network. After this network became operational, the Soviet technical experts at the acceptance check appraised it as advanced, practical, and of good communications quality.

Since 1984, when this radiotelephone was first put into production by Plant 716, over 2,000 sets have been manufactured and put on the market. Product quality now meets mid-eighties international standards.

It has been learned that the USSR and several East European nations plan within the next 10 years to expend huge sums on purchase of communications equipment to modernize their information industries. The Chinese have experience in setting up inter-telephone-office communications based on store-program-controlled exchanges interconnected with this type of small-capacity wireless communications system, which manifests no interference on any channel and has unusually clear voice reproduction; the Soviets and East Europeans, on the other hand, do not have strength in development of 150MHz civilian communications equipment. The arrangement has opened up a new marketing route for this product, the domestic market for which—concentrated in transportation, mining, petroleum exploration, forestry, and rural communications—has contracted in recent years.

**Power System Frequency and Load Curve Control by Inductive Energy Storage**

*917K0309A Minsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ENERGETIKA*  
in Russian No 4, Apr 91 pp 26-30

[Article by Yu. S. Petrusha, Belorussian Polytechnic Institute; submitted by the Power Industry Research Lab]

UDC 621.311.004.13.003.1+621.319.4

[Abstract] Two basic purposes of inductive energy storage devices on the basis of superconducting magnetic systems (SPIN) - to control the 24-hour load curve and frequency of power systems - and the advantages of SPIN's, such as their high response speed, high efficiency, and the lack of mechanical control links, are addressed. The operating conditions and structure of power plants with and without SPIN's are compared. It is shown that the economic impact from using SPIN's largely depends on the conditions of their use and varies from tens to hundreds of rubles per kilowatt of available power and that this impact can be increase by combining the functions of covering variable load curve and frequency control; the use of SPIN's to facilitate introduction of controlled nuclear power plants (AES) and replace fuel oil burning frequency control plants with their subsequent transition to coal is very efficient. References 2; tables 4.

**Tests of Numerical Electric Power Quality Meter**

*917K0309B Minsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ENERGETIKA*  
in Russian No 4, Apr 91 pp 46-54

[Article by V. S. Kakhanovich, A. S. Vershinin, Belorussian Polytechnic and Novopolotsk Polytechnic Institutes]

UDC 621.311:621.31.7

[Abstract] The design of a prototype electric power quality index (PKE) meter and the type of output data on the current parameters of electric power quality per cycle, i.e., the frequency deviation, voltage deviation, voltage harmonic distortion factor, positive, negative, and zero phase-sequence voltage, and positive, negative, and zero sequence phases, are presented. In contrast to previous designs, the new device does not need a microprocessor chip while the measurement data are output to punch cards using YeS-1022 computer (EVM) code; the meter contains a multichannel voltage-to-number converter (MPNK) and current-to-voltage converters. The device employs the method of averaging the measurements of instantaneous voltage and current values over 10 cycles. The results of harmonic analysis of the voltage curve are summarized and six operating modes of the power quality index meter are described. The meter uses 380/220 V, 50+/- 1 Hz three-phase power supply and its

power demand is 80 VA; it weighs 5.5. kg. The quality meter has stable metrological characteristics. References 8; tables 6.

**Problem of Financial Incentives in Power Industry: Discussion**

*917K0309C Minsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ENERGETIKA*  
in Russian No 4, Apr 91 pp 118-121

[Article by L. D. Gitelman, V. V. Khanin, O. M. Rostik, B. Ye. Ratnikov, Urals Polytechnic Institute]

UDC 621.31:62.014

[Abstract] One aspect of the problem of financial incentives in the electric power industry related to the remuneration fund formation (FOT) of power industry pools during the transition to a market economy is considered. Two remuneration fund components, the wage fund (FZP) and the bonus fund (FMP) are examined. Since the remuneration fund formation system is unsatisfactory, it is stressed that high end results (KR) should be maintained. An analysis of the state of financial incentives led to formulating the following trends of solving the problem: to develop a flexible financial incentive management system in an industrial power association (OIEiE); to expand the sources of financial incentives for industrial power associations; and to transform the industrial power association remuneration fund formation principles. It is shown that during the transition to a market economy when economic processes are characterized by high volatility, industrial power associations should ensure that their wage fund is guaranteed with respect to the standards which are based on the work force, wages, and salaries, thus helping to avoid social tensions and contributing to stability of power industry operation. In the long run, a guaranteed minimum wage should be set up in the power industry.

**Basic Premises for Developing Long-Term USSR Energy Program**

*917K0304A Moscow PROMYSHLENNAYA ENERGETIKA* in Russian No 4, Apr 91 pp 2-5

[Article by A. A. Troitskiy, USSR State Planning Board]

[Abstract] The author's report to a congress of power industry workers held in Moscow on 12-13 December 1990 about solving a crucial problem facing the power industry - providing fuel and energy to the country, a task which call for developing a long-term strategy and determining the development scale of the fuel and energy complex (TEK) in a market economy - is summarized. Energy conservation is identified as the crucial strategic trend in meeting the country's demand for fuel and energy resources (TER) and a key component of the Energy Program. The state of extraction and production of basic primary TER's, i.e., oil, gas, and coal, as well as

nuclear power plant (AES) operation and use of renewable resources are examined in order to estimate possible ways of ensuring the necessary increase in the TER production with the maximum efficiency and a minimum cost to the society. On the basis of this analysis, the development of electric power generation is forecast for the next 20 years. The regional aspect of the problem of energy supply and its ecological impact are addressed.

### **State of Power Savings at Moscow's Industrial Enterprises**

*917K0304B Moscow PROMYSHLENNAYA ENERGETIKA in Russian No 4, Apr 91 pp 5-8*

[Article by V. V. Zhizhin, D. I. Kharaz, N. I. Ryabtsev, Tekhenergokhimprom Scientific Production Association, Moscow]

UDC 658.26.003.1(470.311)

[Abstract] The pattern of energy and fuel resource (TER) consumption at Moscow's industrial enterprises since 1987 is analyzed and it is shown that the level of consumption has remained relatively steady in the past four years despite an increase of outlays aimed at improving the working conditions, such as ventilation, lighting, and air conditioning, thus attesting to a new trend in energy consumption which is related to the implementation of energy saving policies. The energy saving policy - a complex of economic, management, and engineering measures - and its underlying principles are analyzed in detail. The principal factors which retard the development of energy conservation in Moscow's industry are summarized and four problem areas are identified: the low level of prices for energy resources and a lack of economic mechanisms for stimulating energy savings; limited financial and physical resources necessary for implementing energy saving measures; lower than necessary staff training level; and a lack of data on energy saving methods and technologies. It is shown that the development of an association of energy consuming enterprises would help to eliminate said shortcomings.

### **Increasing Low-Pressure Boiler Blowdown Water's Permissible Salt Content**

*917K0304C Moscow PROMYSHLENNAYA ENERGETIKA in Russian No 4, Apr 91 pp 13-21*

[Article by B. Ye. Akopyants, Scientific Production Association at the Central Boiler and Turbine Research Institute imeni I.I. Polzunov, Leningrad]

UDC 658.181:621.184.28.004.68

[Abstract] Gas and oil fired DyE-16-14GM and DYe-25-14GM boilers with an output of 16 and 25 t/h, respectively, commercially produced by the Biysk Boiler Plant and intended for operation with feedwater with an elevated salt content ( $\geq 500$  mg/kg) and their design

specifications are outlined. Devices which make it possible to operate the boilers using blowdown water with a high salt content specially developed for the boilers on the basis of external centrifugal separators which were scaled down so as to be placed inside the drum are described in detail. It is shown that the new devices are simple to make but call for considerable labor outlays for assembly and installation inside the boiler drum, primarily due to the constricted dimensions of the demineralizing plant; they also call for an improved quality of inside surface finish after the welding operations. Upon request, the NPO TsKTI can provide the necessary specifications, recommendations, and technical supervision for the manufacturing and refurbishing of separating devices. Figures 2.

### **On Streamlining User Electric Lab Operation and Management**

*917K0304D Moscow PROMYSHLENNAYA ENERGETIKA in Russian No 4, Apr 91 p 54*

[Information Letter No. 94-6/3-ET of 22 Jan 91]

[Abstract] The procedures for using electrical labs which perform tests and take measurements during the production, assembly, adjustment, startup, operation, and repair of users' electrical installations is established in order to streamline the operation management of fixed and mobile electrical testing and measurement stations, units, and user labs (hereinafter referred to as electrical labs). They call for strict adherence to state standards, metrological support regulations, and safety requirements and specifically prohibit operation of electrical labs not registered with the State Energy Supervision Board. For the purpose of this information letter, electrical labs with portable sets of instruments are regarded as mobile electrical labs.

### **In-Process Game for Training Nuclear Power Plant Operators to Operate During Emergency**

*917K0311A Moscow ELEKTRICHESKIYE STANTSII in Russian No 2, Feb 91 pp 5-9*

[Article by A. N. Biryukov, Yu. S. Krizhanskaya, V. P. Tretyakov, Kola Nuclear Power Plant]

UDC 621.311.25:621.039.007:331.86.056

[Abstract] The loss of operating staff proficiency due to a lack of work practice and ways of solving this problem are addressed. To reduce the number of errors made due to the lack of proficiency and thus to increase operating safety of nuclear power plants (AES), a Smena-1 [shift] game was developed and implemented at the Kola nuclear power plant in order to supplement existing dynamic models which are incapable of simulating human behavior in emergency situations. The game represents a cooperative simulation of an emergency situation. All moves and their meaning, equipment, evaluations, and comments involved in the game are

described in detail. The game is designed for 17 participants, the operating staff servicing one generating unit which most often take part in eliminating an emergency, who are divided into two groups, the "saboteurs" developing the emergency and the "operators" eliminating it. Both parties learn their roles only before the start of the game. The game reveals the anatomy of the "sabotage", such as moves missed due to the absence of workers from the workplace (lunch break, broke a leg while running back to the workplace upon learning about the emergency), deliberate sabotage (destruction of vulnerable equipment), and sophisticated "sabotage", such as reports on changes in equipment parameters which aggravate the situation. The game has been used for over a year at the Kola nuclear power plant; it is not only well received by the operating staff but in the estimate of experts and personnel is also an efficient means of training operating staff for acting in an emergency and rallying the operating staff in each work shift. References 7; tables 1.

#### **Organizing Promotional and Commercial Activity in Nuclear Power Industry: Discussion**

*917K0311B Moscow ELEKTRICHESKIYE STANTSII in Russian No 2, Feb 91 pp 13-15*

[Article by A. V. Revin, Novovoronezh Nuclear Power Plant]

UDC 621.039:659.1

[Abstract] The need to develop a coherent promotional and commercial activity program in the nuclear power industry in the light of the Chernobyl accident is identified and emphasis is placed on developing a public relations program. Specifically, the system of promotional and commercial activity, the subject of this activity, various types of promotional activity, e.g., public relations, advertising by groups, public institutions, and department, and international advertising, different advertisers both at home and abroad, classification of promotional activity, and forms and resources for promotional activity aimed specifically at the nuclear power industry are considered. Management aspects of the advertising activity are examined. It is stated that if the above program is adopted, it should be complemented with a procedure for developing the source of funding, settling advertising bills, and determining the profitability of various types of advertising. References: 1 Western; tables 1.

#### **Design Principles of Highly Reliable Power Distribution Systems**

*917K0311C Moscow ELEKTRICHESKIYE STANTSII in Russian No 2, Feb 91 pp 49-51*

[Article by Ye. I. Udod, Shevlyakov, Energotekhnologiya i informatika Ukrainian Production Association and Ukrainian Branch of the Rural Electric Development Institute]

UDC 621.316.1.001.12

[Abstract] The concept underlying the design of the rural power supply system is discussed and its shortcomings are summarized. The use of methods of live repairs (PRN) in existing 10 and 35 kV power systems and the problems related to repairs on live wires are outlined. The limitations of live wire repair methods used abroad and the need to develop special methods and devices for this purpose are analyzed. The principles of increasing the reliability of rural electric power distribution systems are discussed. The range of R&D steps to develop electric units for distribution systems of increased reliability suitable for servicing without the power disconnection and methods of working on live wires, including the cases of ground fault in power lines with an insulated neutral, as well as attachments and tools for performing these operations being taken at the "Energotekhnologiya i informatika" Ukrainian Production Association and Ukrainian Branch of the Rural Electric Development Institute are described. A testing range containing 35/10 kV substations and 10 and 0.4 kV power lines is being planned for implementing these measures. References 2.

#### **On Expediency of Using Recording Current and Voltage Indicators to Locate Aerial Line Faults**

*917K0311D Moscow ELEKTRICHESKIYE STANTSII in Russian No 2, Feb 91 pp 54-58*

[Article by A. I. Ayzenfeld, Soyuztekhenergo]

UDC 621.315.1.027.3:621.317.333.4

[Abstract] The drawbacks of using the zero phase sequence parameters for fault location (OMP) in aerial power lines (VL) with a complex electromagnetic coupling, such as bulky computational expressions, and additional problems which arise if there are intermediate step-down substations, both branching and transit, in transit lines are addressed. It is shown that the use of recording current indicators (FPT) and voltage indicators (FPN) which measure the parameters of the emergency negative phase sequence greatly simplifies the calculation of the distance to the short circuit fault since in this case it is not necessary to take into account the mutual induction between aerial lines while it is possible to locate faults not only in the case of a partial ground but also short circuits in two-phase lines without a ground fault. The results of FPT and FPN recording indicator implementation at a complex power system in the Kiev power grid are cited and the block diagram of a section of this power system and its parameters are presented. Deliberate short circuit experiments staged in the Iskra-Fastov power line with the Boyarka branching substation are described. Field tests and subsequent operating experience of FPT and FPN recording indicators show that they make it possible to locate single- and two-phase faults in electromagnetically coupled lines with an adequate accuracy. It is demonstrated that branching substations virtually do not affect the fault location accuracy. References 4; figures 3; tables 2.

**Issues of Ecological and Economic Estimate of Environmental Impact of Aerial Power Lines**  
*917K0311E Moscow ELEKTRICHESKIYE STANTSII in Russian No 2, Feb 91 pp 58-62*

[Article by T. G. Pospelova, O. V. Sviderskaya, Belarusian Polytechnic Institute]

UDC 621.315.1.027.3:577.47

[Abstract] The most important issues of the effect of aerial power lines on the environment, such as eminent domain, felling of trees, limitations of the economic activity in the power line right-of-way, the effect of the

power line's (VL) magnetic field on the biosphere, acoustic noise and TV and radio interference and negative impact on the operation of communication facilities and various instruments, visual pollution, and impact on natural, cultural, archaeological, historical, and other landmarks, are considered. An analysis of these issues reveals that a number of significant factors affecting social and economic systems is not taken into account in power line design. The need for feasibility studies necessary for optimizing the development and operation of power lines is identified. It is shown that fees being charged for the use of natural resources must be increased and their relative value and utility must be differentiated. References 10; figures 1; tables 3.

**Numerical Analysis of Explosively Driven Magnetic Field Generator's Electrodynami c Response Based on Secondary Current Source Method**

917K0318A Kiev TEKHNICHESKAYA  
ELEKTRODINAMIKA in Russian No 3, May-Jun 91  
pp 14-20

[Article by A. P. Popov, A. M. Mechkal o, O. P. Kurakina, Omsk Polytechnic Institute]

UDC 621.37.373

[Abstract] A mathematical model of a high-inductance explosively driven magnetic field generator (VVMG) intended for converting the energy of explosion into the energy of high-power electric pulses is developed, making it possible to reflect with sufficient adequacy the pattern of the physical processes occurring in VVMG's and to optimize their design. The numerical VVMG model is developed on the basis of the secondary current sources method as well as the boundary value condition substantiated in *Tekhnicheskaya elektrodinamika* No. 3, 1984, pp. 20-24. This boundary value condition is suitable in the case of a rapidly progressing process when the electromagnetic field penetration depth in a conducting body is insignificant compared to its dimensions. The condition is met in the case under study. It is assumed that eddy currents are distributed on the conducting body surface in an infinitely thin layer whereby only the tangential magnetic induction component exists on the conductor/insulator interface. The resulting mathematical model and the technique for numerically calculating the VVMG electrodynami c response make it possible to describe the electromagnetic processes of energy conversion, estimate the parameters which cannot be evaluated by physical modeling, and optimize VVMG design allowing for the effect of all principal structural and electric parameters. References 4; figures 3; tables 1.

**Calculation of Electromagnetic Pressure in Liquid Conductors**

917K0318B Kiev TEKHNICHESKAYA  
ELEKTRODINAMIKA in Russian No 3, May-Jun 91  
pp 25-29

[Article by N. L. Isayeva, N. V. Lysak, Electrodynamics Institute at the Ukrainian Academy of Sciences, Kiev]

UDC 538.4

[Abstract] The problem of determining the electrodynami c forces and electromagnetic pressure which develop in systems with a liquid metal working medium under the effect of electromagnetic forces by various numerical methods on the assumption that fluids can be treated as solids, i.e., without taking into account motion in the liquid phase, is addressed and the expediency of considering the issue of this approach's validity and estimating its error is discussed. To this end, the axisymmetric

problem of determining the magnetic pressure in liquid media is considered allowing for the liquid's motion and compared to the pressure calculated on the basis of earlier assumptions for evaluating the adequacy of the models used. The electromagnetic pressure in the volume under study is determined on the basis of the numerical net-point method for a viscous conducting liquid medium with unsteady free boundaries. This pressure is compared to that derived in a rigid conductor approximation. The resulting pressure calculation method also makes it possible to determine the velocity pattern in the volume under study. References 3; figures 2.

**Electromagnetic Conduction Suspension**

917K0318C Kiev TEKHNICHESKAYA  
ELEKTRODINAMIKA in Russian No 3, May-Jun 91  
pp 41-45

[Article by A. Ya. Kolchanov, Mechanical Engineering Institute, Perm]

UDC 621.335

[Abstract] A conduction suspension of the type of magnetic levitation systems with an uncontrolled supporting field based on the principle of interaction among the direct currents in the rotor and stator windings, making it possible to use it for partially or fully equalizing the weight of electric motor rotors, inertial energy storage flywheels, etc., is described and its limitations due to the need to excite direct current directly in the rotor being suspended are discussed. The lifting capacity, active and specific power, and efficiency parameter which makes it possible to optimize the suspension are calculated. Principal analytical relationships are compared to experimental data. It is assumed that the radial component of the force developed by the conduction suspension is compensated for in a certain fashion, e.g., a bearing, so only the axial force component is considered. The suspension design diagram is cited. The model developed for examining the conduction suspension capabilities and its parameters are described. The proposed analytical technique makes it possible to calculate the principal energy and force parameters of the conduction levitation system with a given range of parameters. The suspension is easy to manufacture but when operating in the repulsion mode, it is characterized by low rigidity in the axial direction and requires thermal rotor winding control. References 4; figures 3.

**Three-Stage Electromechanical Converter in Spacecraft Attitude Control System**

917K0318D Kiev TEKHNICHESKAYA  
ELEKTRODINAMIKA in Russian No 3, May-Jun 91  
pp 46-52

[Article by Ye. V. Dvoynikh, Kiev Polytechnic Institute]

UDC 621.313.3

[Abstract] Spacecraft (KA) attitude control systems based either on single-degree of freedom gyros (gyrodynes) or three-stage electromechanical devices with a spherical rotor on an electromagnetic suspension and the shortcomings of each type of system are addressed. The expediency of unifying spacecraft attitude control systems by distributing the angular momentum medium of the gyroscopic stabilization system throughout the entire spacecraft structure, including the least utilizeable space and possibly the outer surface is discussed. A three-stage electromechanical converter (TEP) with a bipolar radially magnetized rotor used as a gyro drive of the type used in homing devices which can be used for developing such a unified system is described. The principle of stabilizing moment formation in various types of angular momentum distribution versions is described. It is shown that the use of small gyro units on the basis of electromechanical converters makes it possible to form the power element of the attitude control system with a random structure determined by the specific spacecraft design and dimensions. By positioning the elementary gyro units on board the spacecraft, it is possible to form a stabilizing gyroscopic momentum applied to the spacecraft without mechanical contact through a magnetic field relative to a random stabilization axis. It is demonstrated that the use of elementary three-stage electromechanical converters in the spacecraft stabilization systems helps to increase its reliability since it is unlikely that all gyro units would fail simultaneously. References 4; tables 5.

#### Possibility of Power Shutoff at Chernobyl, Rovno, and Khmelnitskiy Nuclear Power Plants

917K0318E Kiev TEKHNICHESKAYA  
ELEKTRODINAMIKA in Russian No 3, May-Jun 91  
pp 87-88

[Article by I. S. Nedzelskiy, Electrodynamics Institute at the Ukrainian Academy of Sciences, Kiev]

UDC 621.311:621.313

[Abstract] The possibility of power shutoff at the Chernobyl (ChAES), Rovno (RovAES), and Khmelnitskiy (KhmAES) nuclear power plants (AES) is examined on the basis of the results of analyses of normal steady-state conditions in two versions of Ukrainian Consolidated Power System (OES). The first corresponds to the 1989 supper minimum while the second was used for analyzing normal operation of Ukraine's Consolidated Power System. The feasibility study for the Polesskoye Rectifier-Inverter Substation (VIP). The calculations were made for a constant structure power demand and power generation; the results of version 2 (prospective) analysis demonstrate that Chernobyl, Rovno, and Khmelnitskiy nuclear power plant shutoff may call for shutting off electric power transmission to COMECON (SEV) countries and additionally boosting the 330 kV

electric power transmission line (LEP) as well as changing the generation (and maybe even load) schedule.

#### Method of Decreasing Electric Motor Fan Noise Level

917K0317A Moscow ELEKTOOTEKHNIKA in Russian  
No 4, Apr 91 pp 7-8

[Article by M. P. Kukharskiy, Electric Motors Institute]

[Abstract] A method of improving aerodynamic and energy parameters of series 4AM and AI 132-250 mm induction motors by making fan housings with a smaller diameter than that of the bed finning is described. As a result of the new design, electric power demand decreased by 25-50 percent or more due to a drop in the drag and air consumption. In addition, the air velocity rises by 15-25 percent thus lowering the stator winding overheating. Formulae for computing the optimal housing diameter and noise level are derived. The results of aerodynamic and acoustic experiments carried out with 4A180M4 and AIR225M4 motors with identical fan impeller diameters but different housings are cited and compared to each other. They demonstrate that the noise level is reduced by at least 3-4 dBA due to a decrease in the housing diameter and by another 3-4 dBA due to the new impeller design. References 3; figures 3; tables 1.

#### Fire Resistant Cable Insulation Design

917K0317B Moscow ELEKTOOTEKHNIKA in Russian  
No 4, Apr 91 pp 44-47

[Article by E. T. Larina, O. V. Krekhova, M. K. Kamenskiy]

UDC 621.315.21.001.2

[Abstract] The use of fire resistant cable whose insulation is made from inorganic and polymer layers for ensuring continuous functioning of monitoring and control circuits is summarized. The parameters characterizing the cable's performance in a fire, in particular the time to failure and leakage current through the insulation, and methods of measuring them are outlined. A model of fire-resistant cable developed for determining the thickness of individual insulation layers is described. The results of fire resistance tests of cable prototypes with a two-layer insulation consisting of a glass mica tape and polymer layer - PVC plastic or polyethylene - encased in PVC plastic housing with reduced combustibility are presented and failure mechanisms of two-layer cable insulation are established. Recommendations are made for selecting the number of tapes, their width, and overlapping pattern. References 6: 4 Russian; 2 Western; figures 6; tables 2.

**Examination of New Flexible PVC Plastic Brands For Developing Industrial Robot Cables**

*917K0317C Moscow ELEKTROTEKHNIKA in Russian No 4, Apr 91 pp 47-49*

[Article by N. Ye. Molodykh, L. V. Istomina, K. M. Kevroleva, L. D. Kovalenko, V. I. Milov, Khen Teunzuni]

UDC 621.315.616.9:621.315.2.

[Abstract] Conventional rubber-sheathed KGN and KPGSN cables used for making adaptive industrial systems and the inadequacy of their design and operation parameters for use in industrial robots are outlined. The principal requirements imposed on industrial robot cables, e.g., resistance to multiple bending (up to 500,000 cycles), sheathing oil and fuel resistance, flame retarding ability, a service life of at least 12 years, stability to ambient temperature variations, moisture resistance, conductor temperature endurance, a conductor insulation resistance of at least 20 MΩ/km, etc., are cited. The properties of flexible PVC plastics determined by tests of new pilot batches of cable sheathing manufactured by the Novosibirsk Chemical Plant are summarized and compared to those of the OMB-60 and I40-13A commercial brands. It is shown that in addition to rupture strength and resistance to bending, the new materials have a much greater resistance to tearing, cutting, and puncture. Based on the test results, the new flexible PVC plastics and cables on their basis are recommended for commercial production. Standards governing the properties of new plastic materials are established. References 5: 4 Russian, 1 Western; tables 2.

**Axisymmetric Conducting Body Motion in Solenoid's Pulsed Magnetic Field**

*917K0312A Kiev TEKHNICHESKAYA ELEKTRODINAMIKA in Russian No 2, Mar-Apr 91 pp 22-28*

[Article by Yu. N. Vaskovskiy, L. N. Dynnik, Electrodynamics Institute at the Ukrainian Academy of Sciences, Kiev]

UDC 538.323:531.551

[Abstract] Acceleration of a hollow or solid conducting axisymmetric cylindrical body in a pulsed electromechanical converter (IEMP) whose primary element is a solenoid and secondary - the accelerated body itself, is analyzed allowing for a certain misalignment of the solenoid's and cylinder's axes due to production flaws. The complicated combination of electrodynamic forces and moments affecting the cylinder as a result of the misalignment is examined. A mathematical model is formulated making it possible to analyze the free motion of the cylinder on the basis of the method of magnetically coupled electric circuits allowing for the cylinder's nonlinear properties due to the Joule heating of its conducting materials. The vibratory character of the cylinder axis motion around the

solenoid axis is established. The effect of the body's center of gravity position, length, and initial axial velocity on its motion stability in the magnetic field is analyzed. It is shown that if the center of gravity (TsT) is moved forward, the cylinder motion stability increases. References 3; figures 5.

**Extreme Forms of Free Motion in Electric Circuit**

*917K0312B Kiev TEKHNICHESKAYA ELEKTRODINAMIKA in Russian No 2, Mar-Apr 91 pp 29-33*

[Article by A. V. Novoseltsev, Institute of Energy Savings Problems at the Ukrainian Academy of Sciences, Kiev]

UDC 621.3.011.73

[Abstract] Sinusoidal forms of free motion (variation) of currents and voltages in power engineering and their importance for efficient functioning of electric systems are summarized. An attempt is made to substantiate the extremality (optimality) and determine the existence conditions and physical meaning of the sinusoidal and constant forms of minimal motion in the space of electric circuit. Two basic premises are formulated: that from among all possible states, a free physical system selects the one in which its "actions" are minimal and that the form of motion in the electric circuit space must ensure that the motion surface area of Faraday's tubes remains as small as possible under given conditions. An equation of lines of constant positive curvature whose partial solutions in the form of the direct component and sinusoidal harmonics determine the totality of minimal forms of free motion in the electric circuit structure-space is derived. Complex forms (trajectories) of free motion are represented by a generalized Fourier series in the form of functions of complex analytical whose balance equation is known. It is shown that the expansion of motion into harmonic components is an approximation of this motion at a point of multidimensional space where harmonics represent local characteristics of motion which cannot always be considered to be integral. References 8.

**Determining Own Parameters of Charging Unit Output Stage Transformer of Capacitive Energy Storage Devices**

*917K0312C Kiev TEKHNICHESKAYA ELEKTRODINAMIKA in Russian No 2, Mar-Apr 91 pp 33-38*

[Article by I. N. Zhuravskaya, S. I. Zakrevskiy, Electrodynamics Institute at the Ukrainian Academy of Sciences, Kiev]

UDC 621.314.2

[Abstract] High-voltage charging unit output stage transformers of capacitive energy storage devices (ZU YeNE) characterized by rather high leakage inductance and self-capacitance and the need to analyze these parameters and take into account their effect on the charging process are discussed. A theoretical analysis of the characteristic parameters, i.e., the leakage inductance and self-capacitance, of a charging device transformer with vertically sectionalized windings is conducted and its results are presented and compared to those obtained by an experimental verification performed on 4 kW, 10 kV charging unit output stage transformers with different types of high-voltage winding (OVN) sectionalization. Theoretical calculations are consistent with experimental data. It is noted that these data attest that well-developed vertical winding sectionalization does not significantly change the leakage inductance in the case of series sections but leads to a substantial decrease in self-capacitance and, consequently, increases the transformer's natural series resonance frequency. This must be taken into account in designing charging unit output stage transformers with intermediate frequency boosting to several tens or hundreds of kilohertz. References 4; figures 3; tables 1.

#### Direct Frequency Converters With Subrange Control

917K0312D Kiev TEKHNICHESKAYA  
ELEKTRODINAMIKA in Russian No 2, Mar-Apr 91  
pp 46-50

[Article by B. Ye. Pyanykh, Kiev Civil Aviation Engineering Institute]

UDC 621.314.26:64.382

[Abstract] The use of the subrange control method whereby the control range is divided into individual subranges with successive transitions from subrange to subrange in direct frequency converters (NPCh) consisting of fully controlled bidirectionally conducting switches is described. Control circuits and algorithms of these direct frequency converters are considered. The possibility of improving the shape of the voltage regulator control curve and decreasing the level of distortions resulting from pulse-width manipulation of the converter's output voltage by using the subrange control method is analyzed. Plots of the dependence of the harmonic coefficient on the duty factor are cited. It is shown that there are other possibilities of using the subrange control methods in direct frequency converters since the diversity of their designs helps to develop efficient and economical control laws which make it possible to obtain the load energy with the necessary quality and parameters. References 10; figures 7.

#### Multifunction Magnetometer System for High-Energy Permanent Magnet Testing and Calibration

917K0312E Kiev TEKHNICHESKAYA  
ELEKTRODINAMIKA in Russian No 2, Mar-Apr 91  
pp 103-107

[Article by Ye. A. Andriyevskiy, L. N. Lesnik, Ya. I. Lobunets, Electrodynamics Institute at the Ukrainian Academy of Sciences, Kiev]

UDC 621.317.4

[Abstract] The development of automatic high-efficiency multifunction systems necessitated by improvements in equipment for acceptance tests of the permanent magnet's magnetic properties and their requirements, particularly the ability to operate according to preset programs and the capability of self-adjusting and self-controlling, are summarized. A magnetometer system which meets these requirements is described. The system for measuring the magnetic parameters of permanent magnets made from rare earth metals with cobalt or a combination of neodymium, iron, and boron and bringing their remanent magnetization to a given level is described. Its design features are considered and principal specifications of the measurement system are cited. The resulting multifunction magnetometer system makes it possible to calibrate high-energy permanent magnets with a coercive force of up to 1,800 kA/m and residual induction of up to 1.5 T. The system is also capable of measuring the magnetic parameters of the initial hard magnetic material powders of the above compositions. The coercive force and residual induction measurement error does not exceed 5 percent while the measurement time is shorter than 30 s. The calibration error is under 2 percent and the calibration time is less than 90 s. The system's power demand during the magnetization does not exceed 10 kVA. References 4; figures 2.

#### Probability of Limiting Fault Current Appearance in 220-750 kV Autotransformers

917K0303A Moscow ELEKTRICHESTVO in Russian  
No 3, Mar 91 pp 17-22

[Article by Yu. P. Lvov, V. S. Bogomolov]

UDC 621.314.223.027.8.014.38.001.24

[Abstract] The probability of the development of ultimate short circuit (KZ) currents in 220-750 kV autotransformers - one of the main parameters determining their electrodynamic stability - during service life is considered allowing for the outlook for electric system development. In so doing, it is assumed that the free transient process components are independent variables relative to the induced transient process components, making it possible to analyze the statistical dependence of induced and aperiodic transient process components in autotransformer circuits on system characteristics

independently of each other. An analysis of positive and zero phase sequence impedance in the four largest consolidated power systems (OES) in the USSR shows that their correlations for class 220-500 kV systems are equal to 0.8-0.98, pointing to a very close relationship which in practice is close to functional. It is shown that GOST 11677-85 requirements for the maximum 220-750 kV autotransformer current loads are ultimate for the entire set of autotransformers and that there is virtually no and current load safety margin. Moreover, the maximum fault current may occur in the autotransformer's common or low-voltage winding during its operation in a three-winding mode with a single-phase earthing fault. This should be taken into account in standardizing currents and in the autotransformer electrodynamic stability analysis as well as for checking the short-circuit operating conditions. References 14; figures 1; tables 3.

#### **Leading Edge Formation of High-Voltage High-Power Electron Beam Commutator Control Pulse**

917K0303B Moscow ELEKTRICHESTVO in Russian No 3, Mar 91 pp 56-60

[Article by V. S. Lipatov]

UDC 621.385.8:537.533-523.8

[Abstract] High-voltage electron beam commutators designed on the basis of fully controlled rectifier valves (ELV) with a low lag and high efficiency (KPD) necessary for controlling a number of electrophysical installations, e.g., fusion reactor injectors, powerful microwave (SVCh) devices, etc., by means of forming square voltage pulses lasting up to several seconds with steep edges (tenths of microseconds) are considered. Current-limiting devices which are a key element of such control systems are analyzed and the electron beam commutator control circuit optimization process is examined. The resulting analytical data make it possible to ensure optimal leading edge formation of high-power control pulses of electron beam commutators by using semiconductor control circuits of in thyristor control systems of rectifier valves, thus confirming the efficacy of using ELV-based commutation devices. References 7; figures 6.

#### **Determining Protective Capacitance of Arc Plasma Generator Power Supply Source**

917K0303C Moscow ELEKTRICHESTVO in Russian No 3, Mar 91 pp 70-71

[Article by M. N. Bogomolov, A. V. Bolotov, A. S. Markus]

UDC 621.314.63

[Abstract] The disadvantages of using the high-frequency electrode gap breakdown for igniting an electric arc in plasma generators - power supply source penetration by high voltage which results in either rectifier element

failure or insulation faults between power circuits and the unit housing - are considered. The use of surge-protection capacitors for ensuring reliable power supply source protection in circuits with a series oscillator and ways of calculating this capacitance are described. To this end, experimental data were processed on a computer (EVM) using a standard Fourier series expansion routine while the capacitance was computed using the successive approximation method. The resulting technique made it possible to select a surge-protection capacitor for the laboratory plasma generator power supply source ensuring its failure-free operation for five years. References 4; figures 1; tables 1.

#### **High-Voltage Plastic Insulated Cable: Development Outlook, Life Estimation Methods, Treeing Development Mechanisms**

917K0302A Moscow ELEKTROTEKHNIKA in Russian No 3, Mar 91 pp 2-6

[Article by I. B. Peshkov, M. Yu. Shuvalov, All-Union Scientific Research Institute of Cable Industry]

UDC 621.315.2.027.7:621.315.616.9

[Abstract] The design and manufacturing of high-voltage cables with a cross-linked polyethylene insulation (PI) are briefly summarized. The XLPE used as primary insulation is refined beforehand; both insulation layers and the conducting shielding layer are applied by the extrusion method during a single pass with subsequent curing under pressure in a pure inert gas or coolant medium, this ensuring the absence of moisture and impurity particles and gaseous pockets, as well as shielding irregularities of over 75 µm. General concepts of the "dry" and "moist" insulation aging and breakdown mechanisms allowing for differences in the characteristic time and dimensions typical of various stages of destruction corroborated by experimental data are cited, making it possible significantly to simplify the electrical aging simulation. Methods of estimating the cable's service life are developed in the framework of examining its reliability indicators. A mathematical model of the electric treeing development in the insulation is developed. The resulting principles are applied to cables for various voltage ratings. Ways of improving XLPE-insulated HV cables are analyzed from the viewpoint of the above theoretical concepts. Figures 7: 5 Russian, 2 Western; figures 3.

#### **Production Status and Utilization Outlook of Balanced Communication Cable With Styroflex Insulation**

917K0302B Moscow ELEKTROTEKHNIKA in Russian No 3, Mar 91 pp 9-12

[Article by R. M. Lakernik, G. S. Moryakov, V. N. Spiridonov]

UDC [621.315.2:621.39]:621.315.616.9

[Abstract] The advantages and shortcomings of optic communication cables (OK) and conventional copper-based radio-frequency (VCh) balanced cables are compared. It is shown that despite the rapid implementation of optical cable, conventional cable remains to be a valuable tool in the communication industry. The shortcomings of the conventional balanced RF cables used in state and departmental communication networks, such as the difficulty of TV program transmission, narrow bandwidth, and the related high consumption of nonferrous metals, i.e., copper, per each communication channel-kilometer, as well as the need for balancing and using two-cable communication systems are summarized. It is noted that like any underground communication cables with metallic elements, balanced RF cables with copper conductors are vulnerable to thunderstorms and other external electromagnetic factors. It is demonstrated that the new lightning-resistant cables with styroflex insulation developed jointly by the Moskabel plant and Central Communications Research Institute together with the Cable Industry Research Institute are quite promising for use in area-wide departmental communication networks and in areas which are exposed to lightning discharges and high external electromagnetic factors. Figures 1; tables 1.

#### Development of 1,140 V High-Strength Flexible Shaft Cable

917K0302C Moscow ELEKTROTEKHNIKA in Russian  
No 3, Mar 91 pp 15-16

[Article by G. G. Mishankina, G. I. Nikolayevskaya, A. A. Vershinin, Sibkabel Scientific Production Association]

UDC 621.315.2.016.2

[Abstract] The development of a shaft cable with a 500 m face-to-face length, which is stable to tensile loads and torsion and is flexible enough to be wound on a cable drum, necessitated by the pace of scientific and technical progress in the mining industry is considered. The operating conditions of such a 1,140 V triple-core cable with load bearing elements are outlined and four types of these elements' arrangement are presented. The specifications of the resulting KGVShU 3x3+1x16+7x1.5 mm<sup>2</sup> 1,140 V cable with flexible conductors and a PVC sheathing reinforced with standard zinc-coated wire ropes, such as the breaking load, insulation resistance under normal climatic conditions, permissible long-term conductor temperature, face-to-face length, mass per kilometer, service life, and operating temperature range are cited. It is expected that the economic impact from its production and implementation in the tunneling machine will reach 15,200 rubles. Figures 1; tables 1.

#### Development and Examination of Superconducting Wire for MRI Body Tomograph's Magnetic System

917K0302D Moscow ELEKTROTEKHNIKA in Russian  
No 3, Mar 91 pp 16-19

[Article by O. P. Anashkin, Yu. P. Ipatov, V. Ye. Keylin, I. V. Kirya, A. V. Krivykh, A. V. Rychagov, V. Ye. Sytnikov]

UDC 621.315.55::538.945

[Abstract] The principles underlying magnetic resonance tomography are summarized; it is noted that the use of superconducting magnets not only makes it possible to increase the magnetic field induction to 0.5-2.0 T compared to 0.25 T of resistive magnets thus significantly increasing the sensitivity of examination but also ensures a much higher field stability in time. The design of a wire used in the superconducting magnetic system (SMS) of an MRI tomograph with a 1.5 T induction, a working current of 500 kA, and a current density of  $6 \times 10^3$  A/cm<sup>2</sup> developed at the Atomic Energy Institute imeni Kurchatov is described. The new wire's current-carrying capacity makes it suitable for use in the magnetic system of an MRI tomograph for the entire body which is corroborated by full-scale tests. Calculation data reveal that to ensure a safe transition of the MRI tomograph's magnet to the superconducting state, one should take measures aimed at decreasing the winding temperature during its transition to the resistive state. References 2; figures 4; tables 1.

#### Experimental Investigation of Lateral Resistance and Energy Losses in Transposed Superconducting Wires

917K0302E Moscow ELEKTROTEKHNIKA in Russian  
No 3, Mar 91 pp 19-22

[Article by V. Ye. Sytnikov, G. G. Svalov, I. P. Radchenko, A. V. Zlobin]

UDC 621.315.14::538.945

[Abstract] Total energy losses in flat transposed superconducting wires used in magnetic systems and their components - eddy currents and coupling losses - are considered. The dependence of composite losses in transposed superconducting wires on their design parameters and manufacturing methods is analyzed. It is shown that lateral resistance is the principle manipulated variable in these wires. The materials and methods for measuring the lateral resistance and the dependence of lateral resistance on pressure during cyclic loading and external magnetic field induction is examined. A study of various designs of niobium-titanium wires with copper and copper-nickel matrices demonstrates that by manipulating the design parameters of multiple-conductor transposed wires containing 2,970 superconducting fibers one can change the total energy loss level

by two-three orders of magnitude. References 6: 4 Russian, 2 Western; figures 5; tables 1.

### **Survey and Analysis of Solar Cell Simulators**

*917K0302F Moscow ELEKTROTEKHNIKA in Russian No 3, Mar 91 pp 52-58*

[Article by K. V. Bezruchko, S. V. Gubin, Kharkov Aviation Institute]

[Abstract] The use of solar cells (SB) as primary sources of electric power and the difficulties of studying, experimentally improving, and testing electric power supply systems (SEP) containing solar batteries are outlined. Solar cell simulators (ISB) with a nonlinear voltage-current characteristic (VAKh) similar to that of solar cells which are used in experimental studies of solar cells are classified and three trends of specifying their VAKh's are identified: specifying VAKh without reference sources; specifying VAKh by a reference source; and specifying VAKh by a computer (EVM). Each of these trends is examined individually. In addition, solar cell simulators are classified by the method of ensuring their output power: solar cell simulators with a DC generator, solar cell simulators with a ferromagnetic regulator, and solar cell simulators with a semiconductor regulator. References 9: 4 Russian, 5 Western; figures 10.

### **Features of Commercial Production of Extrathin N70MKhYuE Alloy Bands**

*917K0298A Moscow STAL in Russian No 3, Mar 91 pp 71-74*

[Article by Ye. A. Sizov, N. G. Novoselova, T. A. Khokhlova, V. M. Rozanova, A. I. Vetoshkina, Central Scientific Research Institute of Ferrous Metallurgy]

UDC 669.15'24'26'28-192

[Abstract] The requirements imposed on extrathin bands from new alloys characterized by high performance levels necessary for resistors, especially resistance stability within the -60 to +155°C range, are summarized and the production method of extrathin bands from the N70MKhYuE alloy developed at the TsNIIchermet pilot plant and implemented by the Elektrostal plant are presented. The phase composition of the alloy is described and it is shown that it possesses a unique range of properties which are necessary for making high-precision class resistors. It is also shown that the appearance of the NiMo phase leads to a degradation and instability of electrical properties from smelting to smelting. The resulting study makes it possible to set up stable commercial production of a band with a 1.45-1.55  $\mu\Omega \cdot m$  resistivity and temperature coefficient of resistance of no more than  $6 \times 10^{-6} K^{-1}$ . It is demonstrated that it is expedient to use 0.18-0.20  $\mu m$  thick microcrystalline blanks for making extra-thin resistive bands and to eliminate the forging and hot rolling operations, thus

helping to ensure a high level of electrical properties and their stability from smelting to smelting. References 1; figures 6; tables 1.

### **Synthesis of Single-Shot Integrating Digital Subordinate Electric Drive Control System With Two Quantization Periods**

*917K0300A Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 2, Feb 91 pp 51-58*

[Article by P. Kh. Kotsegub, V. A. Barinberg]

UDC 62-83:681.335.7.001.8

[Abstract] Issues of synthesizing multiplex digital electric drive systems on the basis of the modulus optimum conditions are addressed. It is shown that attaining the limit of response speed may turn out to be a rather complex task due to such system's increased sensitivity to changes in the parameters of its individual elements. A technique for selecting the speed governor parameters in a discrete single-shot integrating subordinate control system with multiple quantization periods in its current and speed control circuits is developed and it is demonstrated that when the system is driven by an intensity set point device, the type of digital integration algorithm used by the set point device must be taken into account. It is established that the optimum speed governor gain depends on the type of mean or instantaneous speed transducer used as well as the presence of pure delay in the system. The resulting relations make it possible to select speed governor parameters for electric drives with different (yet multiple of each other or identical) quantization periods in current and speed control circuits; it is shown that the use of a mean, rather than instantaneous, speed set point device leads to an increase in the integration constant by a quantity which is precisely or approximately equal to the quantization period. References 6; figures 3; tables 1.

### **Application Features of Aluminum in Semiconductor Power Device Fuses**

*917K0300B Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 2, Feb 91 pp 69-79*

[Article by K. K. Namitokov, N. A. Ilina, I. G. Shklovskiy]

UDC 621.316.923.5:669.71

[Abstract] The problems related to using silver as fusible elements of quick-break fuses - its scarcity, high cost, and high-temperature behavior - which necessitated its replacement with aluminum are addressed. Requirements imposed on quick-break fuses are examined and

chemical and physical properties of aluminum are considered. The results of experimental investigations of aluminum fusible elements, their behavior under long-term thermal conditions and under cyclical and random loads and overloads are examined. Aluminum fuse operation in emergency current breaking, alternating current switching, and direct current breaking is analyzed. The performance and specifications of silver and aluminum fusible elements are compared. The resulting data makes it possible to determine preferable applications of quick-break fuses with aluminum elements. Today, several hundred such fuses are in pilot operation in steel smelting furnaces and electric drives. References 11: 4 Russian, 7 Western; tables 3.

### Suggestions for Changing Relationships Between Power Supply Organization and Electric and Thermal Power Users: Discussion

917K0315A Moscow PROMYSHLENNAYA ENERGETIKA in Russian No 2, Feb 91 pp 5-6

[Article by A. I. Makartsev, Likhachev Automotive Works Production Association, Moscow]

UDC 621.311.4.003.1

[Abstract] The relationship between electric and thermal power users and electric power suppliers currently governed by the Rules for Using Electric and Thermal Power is discussed; it is shown that in today's situation, the Rules are at variance with the new laws on property, enterprise, etc., while the principle of *diktat* should be overcome. The following criteria of new mutually beneficial relations to be established on a contractual basis and governed by the principles of financial responsibility are formulated: optimum contract value of power supplied to the user; energy saving policies implemented by the user; reliable provision of electric power to the user; and incentives for equalizing the load curve. It is emphasized that in addition to being mutually beneficial to the user and supplier, the criteria must also be beneficial to the society as a whole due to the mutual concessions made by the parties. The mechanisms necessary for implementing said relationships are proposed.

### 'Energiya' Equipment System and Ye443 Data Collection Device for Designing Computer-Aided Power Demand Monitoring and Control System

917K0315B Moscow PROMYSHLENNAYA ENERGETIKA in Russian No 2, Feb 91 pp 15-18

[Article by S. A. Zhukov, Penza Instrument-Making Plant]

UDC 658.012.011.56.002.5:681.3

[Abstract] The Energiya equipment system (KTS) developed by experts from the Penza Instrument-Making Plant (PPZ) and Vilnius Electrical Instrumentation Plant (VZET) is described; five design versions of the

system are manufactured for 128, 192, 256, 320, and 384 electric power monitoring channels. Energiya hardware consisting of a pulse generator, a data collection device, and a math coprocessor and its software package are described. The range of output data generated by the system is summarized and specifications of system components are outlined. In addition to monitoring electric power variables, the system is capable of monitoring the parameters of superheated and dry saturated steam as well as gas and water. Energiya software (PO) consists of testing software for the DVK-3M computer, testing software for functional units and modules, an RT-11 real time operating system (OS), and special KTS software. The PPZ is developing a new Energiya equipment modification capable of monitoring up to 800 electric power channels. In addition, development of an air quality monitoring system is underway. Figures 3; tables 4.

### Investigation of Solar Energy Accumulation Process in 'Solar Pond'

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[Article by Yu. U. Usmanov, N.K. Radzhabov, Bukhara Technological Institute]

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[Abstract] "Solar ponds" - hydraulic solar engineering structures making it possible to store solar radiation energy in a heat accumulating solution - are described; they are characterized by the solution density gradient in the vertical direction. It is shown that solar ponds can be used in thermal power plants as direct converters of solar energy into thermal. Thermal conditions of the heat storage material (TAM) in existing saline solar pools (SSB), their optimal dimensions, and the temperature distribution in the soil surrounding the pool are analyzed in order to improve SSB design and TAM composition. To this end, the SSB thermal condition was simulated and the dependence of TAM thermal parameters on concentration and the behavior of solar radiation's spectral density was examined. The analysis reveals that 40 percent of the incident solar energy is utilized by the solar engineering structure for the user, thus attesting to the economic efficiency of the device. Construction of the first SSB in the country began in 1968. The procedure for filling the pool so as to ensure a vertical density gradient is outlined and the results of experimental studies of the temperature distribution in depth are presented. The effect of the bottom color on thermal conditions in the pond is investigated. Figures 3.

### Outlook for Using Controlled Magnetic Valve Reactors in Energy Systems

917K0297A Moscow ELEKTROTEKHNIKA in Russian No 2, Feb 91 pp 2-4

[Article by Ye. N. Brodovoy, A. M. Bryantsev, V. V. Ilinichnin, I. D. Lis, V. N. Mozzherin, O. A. Nikitin, G. A. Slavin]

UDC 621.318.435.(088.8).001.4

[Abstract] Design principles of new controlled magnetic valve reactors which make it possible to combine positive aspects of controlled-bias devices and thyristor-reactor groups of static thyristor compensators are outlined: these reactors are based on the concept of a strong (close to the limit) saturation of the magnetic circuit's working sections in the rated condition while the remainder of the magnetic circuit remains unsaturated; in addition, generation of the controlling biasing flux in the active section is based on the successive periodic shunting of some winding by semiconductor keys, making it possible to avoid special biasing power supply source. The most promising version of high-power reactor designs are identified in the course of reactor optimization and study of its characteristics using mathematical and physical models and prototypes with an up to 1 Mvar power. Various aspects of using these reactor in high- and superhigh-voltage electric circuits are presented. Circuit diagrams, active section drawings, and comparative characteristics of various reactors are cited. References 5; figures 4; tables 1.

#### Controlled Reactor Parameter Specifications for Superhigh-Voltage Power Lines

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No 2, Feb 91 pp 4-6

[Article by G. N. Aleksandrov, G. A. Yevdokunin, Leningrad Polytechnic Institute imeni M. I. Kalinin]

UDC 621.318.43.001.5

[Abstract] The specifications and functions of shunt reactors (ShR) in power lines - to compensate for excess charging power, to limit increases in the induced internal overvoltage components, and to quench the open short circuit arc - are summarized and the issue of substituting shunt reactors with controlled shunt reactors (UShR) is considered. The performance of controlled shunt reactors is simulated mathematically. The range of power ratings of controlled reactors intended for compensating for the power line's excess charging power (IZR) is determined and substantiated and data on statistical and dynamic characteristics of a 500 kV reactor with a 180 Mvar power rating are cited. Studies carried out in mathematical model of 1,200 and 2,400 km long 1,150 V lines with a controlled shunt reactor each 600 km demonstrate stable power line operation. It is noted that controlled shunt reactor power must be manipulated by changing the active power in a power line section and adjusting it for the natural power. It is stressed that the use of voltage as the initial parameter for controlling UShR's may lead to erroneous results, especially for long lines. References 3; tables 2.

#### Development Outlook for Controlled 500-1,000 MVA Reactor With 1,150 kV Rating

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No 2, Feb 91 pp 28-29

[Article by M. A. Biki, Ya. Ya. Yarvik (as transliterated)]

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[Abstract] The purpose of shunt reactors in electric power transmission lines - to compensate for excess reactive power while taking into account the need to reduce active power losses, limit overvoltages, ensure stable power transmission, and eliminate emergencies - is explained using the example of a 1,150 kV power line which generates approximately 300 Mvar of capacitive power per 50 km. The outlook for using controlled reactors in 1,150 kV power lines (LEP) is assessed; to this end, the purpose, characteristic features, and requirements imposed on 1,150 kV controlled reactors (UR) and their design are considered. It is shown on the basis of an experimental verification of the theoretical analysis that the development and production of 500-1,000 MVA, 1,150 kV reactors is quite feasible. References 8: 7 Russian, 1 Western.

#### New Designs of Ferromagnetic Devices in Power Engineering

917K0297D Moscow ELEKTROTEKHNIKA in Russian  
No 2, Feb 91 pp 44-48

[Article by Ye. I. Zabudskiy, Yu. V. Yermuraki, S. F. Kozyrin]

UDC 621.318.43.001.5

[Abstract] Ferromagnetic devices developed in recent years for the power industry are briefly characterized and the expediency of using ferromagnetic devices in energy systems for regulating the consumption of excess reactive power in transmission lines, both aerial and cable, and controlling reactive power sources in distribution systems of electric power users (primarily with an inductive load) is explained. The requirements imposed on the design and operating conditions of ferromagnetic devices are outlined; in particular, the design and operation of three-phase controlled reactors, combined three-phase controlled reactors-transformers, three-phase saturating reactors, and combined three-phase reactors-autotransformers (transformers) as well as their specific purpose are presented in detail. An electromagnetic estimate was made in order to compare a number of characteristics of the recently designed reactors to those of power transformers with the corresponding voltage and power; the analysis demonstrates that the characteristics of the new devices are comparable to those of commercially produced transformers. References 4; figures 5; tables 1.

**Physical and Technological Aspects of Building Epitaxial Structures for GaAs Integrated Circuits**

917K0293A Moscow MIKROELEKTRONIKA  
in Russian Vol 20 No 2, Mar-Apr 91 pp 137-141

[Article by Ye. A. Vinogradov, A. G. Dyachenko, E. A. Ilichev, V. N. Inkin, Yu. G. Kachurovskiy, E. A. Poltoratskiy, A. V. Rodionov, and A. V. Fedorenko, Scientific Research Institute of Problems in Physics imeni F. L. Lukin]

UDC 621.382.8.001.2

[Abstract] A comparative evaluation of epitaxial structures with three different architectures is made concerning their suitability for circuit integration of GaAs Schottky field-effect transistors, a major problem being to place the Schottky barrier sufficiently far from both the "free" surface and the substrate. Transition from uniform doping to a buried layer and to a  $\delta$ -layer is considered from this standpoint, a  $\delta$ -layer offering the best solution in terms of physical properties and especially so at higher operating temperatures. Such a structure is shown to have the highest transconductance of all, with the lowest saturation current and the lowest electrical resistance of parasitic source or drain regions. These conclusions are drawn from the results of contactless and, therefore, accurate measurements of electron mobility  $\mu$  and electrical conductivity  $\sigma$  at 4 K and 77 K temperatures. Both were measured by nondestructive methods involving absorption of microwave power by free carriers in waveguides or quasi-open systems, the electrical conductivity having been measured in an MASS 03 quasi-optical submicron-wavelength mass spectrometer. Magnetoresistance measurements, Hall effect measurements, and capacitance-voltage measurements made with small signals using special test cells have yielded profiles of the electron mobility  $\mu$  and the electron concentration  $N$  in homogeneous structures as well as in buried-layer structures and in  $\delta$ -layer structures, also the dependence of the electron mobility  $\mu$  in buried-layer structures on the thickness  $d$  of this layer and on the product  $Nd$ . The dispersion of transistor transconductance and saturation current is found to be about the same in all structures, which indicates a need for refinement of the technology with better control of the metal-semiconductor interface. An additional factor in favor of  $\delta$ -layer structures is the possibility of strongly doping them to an electron concentration up to  $N \approx 5 \times 10^{13} \text{ cm}^{-2}$  and thus using them as contact  $\delta$ -layers in integrated-circuit structures. Figures 3; tables 1; references 12.

**Two-Level Metallization System for LSI Circuits with Large Area of Second-Level Metallization**

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in Russian Vol 20 No 2, Mar-Apr 91 pp 150-154

[Article by Yu. P. Snitovskiy, L. Ya. Portnov, and A. L. Lankevich, Minsk Institute of Radio Engineering]

UDC 621.382.8.002

[Abstract] Metallization of two levels in LSI circuits with Al-Ti pseudoalloys is considered, the Ti/Al+(3-5 vol. percent)Ti/SiO<sub>2</sub>/Ti/Al metallization system having been found to satisfy all main requirements concerning metallization of the first level. These are not only high-quality lithography during subsequent etching with a liquid agent but also that it must make low-resistance contacts with p-Si and n-Si substrates, that it does not short out poorly shielded subjacent p-n junctions, and that it not form deep protuberances which will puncture the dielectric interlayer material so as to cause interlevel shorts. Those concerning metallization of the second level are that it make close contact with metallization of the first level through not only large windows but also small windows ones, that it not strongly interact with the dielectric interlayer material so as to raise the probability of interlevel shorts, and that it be weldable for connection to leads by thermal compression or ultrasonic microwelding. The satisfactory range of Ti concentration in the first-level metallization was determined experimentally by vapor deposition from separate Al and Ti crucibles in the "Oratoriya-9" electron-beam metallizing apparatus, on the basis of appropriate formulas involving thickness of pure Ti and Al+Ti layers built up within the same time under identical conditions. Lithography was performed in a second experiment with a liquid etchant, an aqueous solution of H<sub>3</sub>PO<sub>4</sub> + HNO<sub>3</sub>, COOH, which yielded the dependence of the etching rate and of the depth of the etch wedge on the Ti concentration. These experiments have revealed that, while the Ti content in the second-level metallization ensures a close contact with the first-level metallization and weakens the interaction of Al with interlevel SiO<sub>2</sub>, it also degrades the weldability of the second-level metallization. Inasmuch as the weldability of Al-Ti pseudoalloys is inferior to that of pure aluminum, Al + (3-5 percent)Ti metallization is not suitable for the second level. Figures 4; tables 1; references 4.

**Internal Photoamplification in Planar GaAs Surface-Barrier Structures**

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[Article by N. M. Ushakov, A. N. Solodkiy, V. E. Vyduts, V. I. Petrosyan, A. A. Telegin, and V. F. Dvoryankin, Institute of Radio Engineering and Electronics, USSR Academy of Sciences, Saratov branch]

UDC 621.383

[Abstract] An experimental study concerning photoamplification of a signal in planar GaAs surface-barrier structures was made, epitaxial n-GaAs layers for this study having been formed on semiinsulator substrates with aluminum coating. These aluminum films, deposited under ultrahigh vacuum, had made it possible to establish 0.6-0.8 eV high potential barriers by means of electron-beam lithography in a ZRM-12 apparatus. The thickness of those n-GaAs layers ranged from 5 to 14  $\mu\text{m}$ .

**Solid State Circuits**

and the electron concentration in them ranged correspondingly from  $1 \times 10^{14}$  to  $9 \times 10^{14} \text{ cm}^{-3}$ . The structures were formed into interdigital devices with a 100  $\mu\text{m}$  square aperture, with 4  $\mu\text{m}$  wide electrodes spaced 6  $\mu\text{m}$  apart, and Mott barriers to the GaAs layers. Their dark current-voltage characteristics over the 0-20 V range and the dependence of their dark electrical conductance on the reverse bias voltage over the 0-9 V range were measured at two frequencies, 1 MHz and 1 kHz, with the aid of a TR-4805 characterograph and two electrical instruments. Those interdigital devices with a low surface barrier (0.61 eV) were found to be in two states, an unstable one when containing a majority donor impurity and a stable one without it, their current-voltage characteristic in the unstable state being a hysteresis loop with a nonmonotonically ascending upper branch (current peak at some low voltage) and a monotonically descending lower branch. The hysteresis is most likely attributable to capture of majority charge carriers by deep traps in the upper half of the forbidden band in GaAs. The conductance was found to be correspondingly much higher at the 1 MHz frequency, the signal period being too short for carriers to become entrapped, than at the lower 1 kHz frequency. The photosensitivity of those interdigital devices in terms of amperes per watt was measured with a KSVU-2 apparatus including a spectroscope and photoelectric transducers, for a determination of its dependence on the reverse bias voltage over the 0-12 V range and its spectral characteristic over the 600-100 nm range of wavelengths. These measurements have revealed a photoamplification effect at the 878 nm wavelength, namely internal photoamplification of a signal in such a device under both a d.c. voltage bias and incident 878 nm radiation modulated at a frequency of 10 Hz. Evidently the electron-hole pairs induced by such a radiation redistribute the voltage drop across the interelectrode gap with the cathode fall becoming larger, electron capture and injection thus becoming more intense so that internal photoamplification can occur. Figures 4; references 2.

**GaAs Hall Probes**

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in Russian Vol 20 No 2, Mar-Apr 91 pp 183-188*

[Article by N. I. Dobrinska and Ts. P. Mikhaylova, Institute of Applied Physics at Bulgarian Academy of Sciences, Plovdiv (Bulgaria), and I.B. Velchev, Plovdiv "P. Khilendarski" University]

UDC 621.382

[Abstract] An experimental study of two Hall probes was made, both with an epitaxial n-GaAs/i-GaAs structure but each with a different material of the semiinsulator substrate: [100] GaAs:Cr and [100] GaAs:In single crystals respectively. Both were symmetrically cruciform with a 0.3 mm wide and 0.95 mm long active region. Their electrical characteristics were determined on the basis of Hall voltage measurements with a "Philips" PM

2528 digital multimeter, magnetic induction measurements with a "Systron Donner" 3102 A teslameter over the 0-1 T range, and electrical resistance measurements. Measurements were made with the control current set successively at 2.5 mA, 5 mA, 10 mA, and the temperature in each case varied from -190°C to +190°C, for the purpose of determining the magnetic induction dependence and the temperature dependence of both the Hall voltage and the electrical resistance. The data indicate the influence of the transition layer on the substrate on these characteristics depending on the substrate material, this layer causing the electron mobility to decrease and the magnetic induction dependence of the Hall voltage to become nonlinear. Further examination has revealed a lower dislocation density in the GaAs:In structures and thus a much weaker influence of that transition layer on the epitaxial films. This explains the superior characteristics of such a Hall probe, namely better linearity with a much lower residual Hall voltage after removal of the magnetic field and higher thermal stability with a much smaller temperature coefficient of Hall voltage at least over the -50-(+150)°C range. The temperature dependence of the electrical resistance of was found to be linear over the -160-(+190)°C for the GaAs:In probe and only over the -140-(+190)°C range for the GaAs:Cr probe. Figures 3; tables 1; references 20.

**Directional Bulk Structures for Microwaves**

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in Russian Vol 20 No 2, Mar-Apr 91 pp 189-197*

[Article by V. I. Gvozdev and V. A. Shepetina, Moscow Institute of Electronic Apparatus Design]

UDC 621.382

[Abstract] A directional coupler for microwaves is described which consists of coupled asymmetric lines in a tee configuration, with bilaterally metallized vertical dielectric plate and a horizontal high-permittivity dielectric plate unilaterally metallized on the bottom side. The coupler is excited through two segments of an asymmetric strip line on the upper surface of the horizontal plate, those two segments being separated by the vertical plate and each shorted by the metal rib on its side. A strong coupling, up to 0.5 dB, is attainable with such a structure without technological difficulties and it is readily connected to transmission lines or weak-link devices. In order to ensure that the even mode and the uneven mode have equal phase velocities, the phase velocity of each being strongly frequency dependent, it is proposed to modify the shape of the vertical metal ribs by cutting rectangular windows in them and through the dielectric plate between them. This eliminates the need to match the material (dielectric permittivity) of the vertical plate with its height and thickness as well as with both material (dielectric permittivity) and thickness of the horizontal plate for each combination of these three parameters and for different frequencies. Design and performance analysis of such a directional coupler are

based on electrodynamics and the equivalent circuit. Theoretical calculations are supplemented with experimental data on 15 different window configurations. Figures 4; references 9.

### **Effectiveness of Hardware Redundancy in Raising Fault Immunity of Digital VLSI Circuits**

*917K0293F Moscow MIKROELEKTRONIKA  
in Russian Vol 20 No 2, Mar-Apr 91 pp 198-207*

[Article by A. A. Ivanov and I. I. Shagurin, Moscow Institute of Engineering Physics]

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[Abstract] Increasing the production yield of acceptable VLSI circuits by introducing hardware redundancy and thus raising their fault immunity is considered, several methods of laying out the hardware redundancy being comparatively evaluated for efficiency. These are triple modular redundancy or duplication with self-checking and use of error-correcting codes. An analysis of their functional and logic schemes indicates that triple modular redundancy and duplication with self-checking are the fastest methods, both introducing about equal additional time delays. While duplication with self-checking may require less redundancy, it may also require a larger area. Use of correcting codes minimizes the necessary redundancy, separable codes such as AN codes and L-residual codes among them, the Hamming code being most efficient in data transfer and memory modules. On the basis of this analysis are recommended duplication with an AN code for a 23x23-bit matrix multiplier, duplication with a residual code for a 24-bit adder-subtractor, triple modular redundancy with a biresidual code for a 0-24 bit combination shifter, and duplication of periphery or triple modular redundancy with the l=1 Hamming code for a memory in VLSI circuits which process 32-bit operations with a floating decimal point. Figures 3; tables 1; references 8.

### **Two-Dimensional Modeling of Ion Implantation Technology of Forming Submicron Source-Drain Regions in MOS Transistors**

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in Russian Vol 20 No 1, Jan-Feb 91 pp 7-15*

[Article by A. F. Burenkov, A. I. Kirkovskiy, and V. A. Tsurko, Institute of Application Problems in Physics at Belorussian State University imeni V. I. Lenin and Institute of Mathematics at BSSR Academy of Sciences]

UDC 612.382:519.6

[Abstract] The technology of As-ion implantation and subsequent heat treatment of thus produced source-drain regions in MOS transistors is analyzed on the basis of physical and mathematical modeling, such regions being of intricate shape and of submicron size in the 0.1  $\mu\text{m}$  class with high impurity concentrations and large

concentration gradients so that a one-dimensional approximation is inadequate and a two-dimensional description is necessary. The annealing time is usually short, ranging from 10 ms to 1000 s, multiple local implantation of one (As) or several impurities being followed by compatible diffusion. The mathematical model is the fundamental system of partial differential equations for  $p = k_d$  donor impurities +  $k_a$  acceptor impurities, each equation describing the kinetics of an impurity redistribution during the heat treatment and due to drift in the electric field. The total rate of change of impurity concentration  $N = N_i(x, y, t)$  ( $i = 1, 2, \dots, p$ ) is the algebraic sum of two partial rates of change in the  $x, y$  directions respectively and each of these partial ones is in turn the algebraic sum of two products:  $x$ -gradient of  $D$  by  $x$ -gradient of  $N$  plus  $x$ -gradient of  $D_N$  by  $x$ -gradient of  $\Psi$  and  $y$ -gradient of  $D$  by  $y$ -gradient of  $N$  plus  $y$ -gradient of  $D_N$  by  $y$ -gradient of  $\Psi$  respectively ( $D, D_N$ -diagonal matrices of diffusion coefficients,  $\Psi$ -electrostatic potential). All the parameters in this system of equations have been calculated by numerical solution of that system of equations using algorithms consisting of additive schemes with a cumulative approximation. These calculations together with experimental data based on the study made by J. Albers, P. Roitman, and C.L. Wilson (IEEE TRANSACTIONS Vol ED-30 No 11, 1983) have yielded concentration profiles of As in intrinsic Si substrates and, according to the study made by A.E. Schmitz and J.Y. Cheng (IEEE TRANSACTIONS Vol ED-33 No 1, 1986), concentration profiles of As in Si substrates along with concentration profiles of boron background impurity. In the Albers-Roitman-Wilson experiment As ions were implanted at room temperature in doses varying over the  $10^{16}$ - $10^{21}$   $\text{cm}^{-3}$ , at a 7° angle to the [100] axis of the substrate so as to avoid channeling, implantation being followed by a 30 min long heat treatment in an inert argon atmosphere at various temperatures covering the 900-1200°C range. Figures 3; tables 1; references 8.

### **Changes in Properties of Semiconductor Materials Caused by Action of Nanosecond and Microsecond Microwave Pulses**

*917K0291B Moscow MIKROELEKTRONIKA  
in Russian Vol 20 No 1, Jan-Feb 91 pp 21-25*

[Article by D. Ye. Abdurakhimov, F. Sh. Vakhidov, V. L. Vereschagin, V. P. Kalinushkin, M. G. Ploppa, and M. D. Rayzer, Institute of General Physics, USSR Academy of Sciences]

UDC 621.315.592

[Abstract] An experimental study concerning the behavior of impurities in Si and Ge crystals under treatment with microwave pulses and resulting changes in the properties of these two semiconductors was made, as method of measurement having been selected infrared radiation low-angle scattering sensitive to agglomeration of free charge carriers. The main part of the experiment

involved dislocationless Si crystals grown by the Czochralski method and doped with either phosphorus (Si:P,  $\rho \approx 4.5$  ohm.cm) or with boron (S:B,  $\rho \approx 2$  ohm.cm), dislocationless pure p-Si crystals ( $\rho \approx 10$  kohm.cm) grown by the floating-zone method, and pure Ge crystals ( $N_A \cdot N_D \approx 10^{12}$ , dislocation density  $\approx 1000$  cm $^{-2}$ ) grown in a hydrogen atmosphere. A gyrotron with a Terek-2 accelerator generated 7-8 mm microwave pulses of 15 ns duration with a power of 5-10 MW. A periodically pulsed magnetron oscillator with discharge under high pressure generated 8 mm microwave pulses of 1-6  $\mu$ s duration with a power of approximately 60 kW at a repetition rate of 25 Hz. Measurements were made using a radiation beam of a continuous-wave CO<sub>2</sub>-laser with a power of about 1 W. During operation of the Terek-2 accelerator there were also X-rays emitted, their intensity reaching about 7 mR per nanosecond pulse. A control experiment with X-rays only and no nanosecond microwave pulses revealed no changes in the properties of semiconductors larger than the measurement error. In the experiment with the magnetron oscillator there were no X-rays emitted. The scattering patterns were, however, found to change appreciably and especially upon treatment with microwave pulses, the magnitude of these changes depending also on the pulse energy and the number of pulses. These changes were evident not only in Si:P and Si:B specimens but also in pure Si and pure Ge specimens. They are hypothetically attributed to the presence of many metastable centers and their restructurization as a result of changes in their charged state caused by microwave irradiation, their restructurization in turn causing the charge carrier concentration around impurity cluster to change. Their transition to their original state after the microwave treatment, at room temperature, was found to restore the original scattering pattern but to take a long time up to several months. Figures 1; references 11.

### Use of Test Structures for Monitoring Technology of LSI Interlevel Interconnections

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in Russian Vol 20 No 1, Jan-Feb 91 pp 26-33

[Article by A. S. Valeev, Ye. N. Ovcharenko, V. A. Shishko, and T. P. Traynis, Scientific Research Institute of Molecular Electronics

UDC 621.382

[Abstract] Quality control of VLSI interlevel interconnections with the aid of test structures is considered, a method of chip inspection being described which makes it possible to separate systematic defects due to imperfect technology from random defects due to a variety of causes. A chip with a surface area  $S$  is assumed to consist of regions with a high density of (first-order) surface defects covering an area  $S_1$ , regions with a low density of (second-order) defects covering an area  $S_2$ , and regions with systematic "deep" defects covering an area  $S_0$  so that  $S = S_0 + S_1 + S_2$  and the yield of acceptable chips,

based on a Poisson distribution of random defects, is then  $P = P_1 \exp(-\lambda_1 A) + P_2 \exp(-\lambda_2 A)$  (highly defective part of surface  $P_1 = S_1/S$ , slightly defective part of surface  $P_2 = S_2/S$ ,  $\lambda_{1,2}$  denoting the specific defectiveness of each order in terms of failure rate, breaks, and shorts per unit conductor lengths of per unit surface area). As indicator of defects is used a conventional test cell, a chain of make-before-break contacts with additional leads to contact pads through 150, 300, 600, 1200, 2400, 4800, 9600, 19200 contacts. Six such chains with 5x5, 4x4, 3x4, 3x3, 2x4, 2x2  $\mu\text{m}^2$  large contact windows respectively are placed on the chip, for the purpose of determining how the density of defects depends on the contact window area. The test set includes also MOS-capacitors for electrical measurement of the oxide layer thickness, "contact in series with resistor" elements for measurement of the contact resistance, and an array of chains containing 200 make-before-break contacts with 5x5, 4x4, 3x4, 3x3, 2x4, 2x3, 2x2, 1.5x2.5, 1.5x1.5  $\mu\text{m}^2$  large windows for estimation of large losses. For an experimental validation of this inspection method, test cells were produced for chips with two-level interconnections on 27 silicon substrates with 0.55  $\mu\text{m}$  thick SiO<sub>2</sub> dielectric interlayer films. Four groups of chips were tested, the chips of one group having a 0.6  $\mu$  thick Al + 1 percent Si lower-level conductor and a 1  $\mu\text{m}$  thick aluminum upper-level conductor, the chips of the other three groups having respectively Pt + 2 percent si, Ni + 2 percent Si, Ti + 2 percent Si lower-level conductors and a 0.5  $\mu\text{m}$  thick Al + 1 percent Si upper-level conductor. Prior to formation of the silicide layers, polysilicon conductors on separate substrates had been doped with phosphorus (50 keV,  $\mu\text{C}$ ) and with boron (80 keV, 30  $\mu\text{C}$ ). Prior to subsequent deposition of the upper-level conductors, the contact windows had been "renovated" with an NH<sub>3</sub> in H<sub>2</sub>O<sub>2</sub> solution. Insertion of a 0.15-0.2  $\mu\text{m}$  thick TiW film under an Al + 1 percent Si upper-level layer prevented its interaction with the lower-level silicide layer. The results confirm the effectiveness of this method in not only separating systematic defects from random defects but also in determining the fraction of the chip surface containing those systematic defects. The electrical contact conductance was found to depend linearly on the contact window area with slope the slope in turn depending on the degree of chip perfection, which indicates a 100 percent inspection of each contact window. Figures 2; tables 1; references 7.

### Outlook for Use of Superconductivity in Computer Technology

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[Abstract] Although the availability of high- $T_c$  superconductor materials does not simplify the design of superconducting computer hardware but rather creates new technological problems such as fabrication of high- $T_c$  Josephson junctions and multilayer interconnections, introduction of superconductors into the computer technology is viewed as beneficial and promising for the development of a supercomputer. The initial enthusiasm about this concept must, however, be tempered by consideration of the many difficulties along the road to a superconducting supercomputer, just as in the case of an optoelectronic supercomputer. The essential aspects of supercomputer development are not only steadily increasing the computer productivity and the memory capacity, and improving the computer reliability, but also steadily reducing the labor intensity of computer manufacture as well as the cost of computer operation, all this being attainable by a higher degree of circuit integration and a higher packing density. The most difficult problem may be to ensure high reliability and long life of computer components. One possible solution is a much lower operating temperature, as demonstrated by the ETA-10 cryogenic supercomputer with liquid-nitrogen cooling. Such a mode of operation makes it feasible to change from bipolar transistors to field-effect transistors in high-speed logic circuits. At a much lower temperature, moreover, degradation processes responsible for computer failure are much very slow, owing to the low electric current density in conductors and light heat loads on chips, another advantage being the very low electrical resistance of interconnections. The logic voltage difference, proportional to the absolute temperature, is thus much lower and the quality of logic elements is correspondingly much higher in terms of a much smaller "time delay x dissipated power" product. On the premise that dropping to a cryogenic temperature is absolutely necessary if a higher packing density and a higher operating speed of components is to be made possible without reduction of reliability and without excessive energy consumption, and that introduction of high- $T_c$  superconductor materials will solve the various

problems associated with operation at such temperatures, these materials should be introduced as follows: 1) bulk or film superconductor busbars (to the power supply) having no d.c. resistance and featuring a  $10 \text{ kA/cm}^2$  or higher critical current density; 2) superconductor coatings almost ideally diamagnetic over almost the entire useful frequency range as shields against information leakage and against interference from external electromagnetic fields; 3) wideband multi-channel superconductor communication links without a frequency-dependent skin effect and, therefore, with an up to 1 THz high cutoff frequency; 4) superconductor cables transmitting synchronization signals without velocity dispersion or pulses with very short rise and fall times; 5) multilayer film-superconductor assemblies featuring a  $1 \text{ MA/cm}^2$  or higher critical current density on switchboards, insignificant signal attenuation and distortion making it feasible to pack submicron wide strip lines and separate them by submicron wide clearances on  $10-100 \text{ cm}^2$  large surfaces of special substrates with minimum crosstalk; 6) multilayer film-superconductor printed circuits on connector boards with a  $1000 \text{ cm}^2$  or larger areas; 7) multilayer superconductor interconnections featuring a  $10 \text{ MA/cm}^2$  or higher critical current density on semiconductor chips; 8) superconductor microcircuits and "hybrid" microcircuit systems combining logic operations with data storage and data transmission, made feasible by use of closed superconductor rings which confine magnetic flux and Josephson junctions which feature a  $1 \text{ MA/cm}^2$  or higher critical current density. Polycrystalline and single-crystal superconductor films are considered for communication lines on computer switchboards with very-large-scale circuit integration. Their design parameters and their performance characteristics at 80 K temperature are quantitatively estimated on the basis of empirical formulas and of experimental data pertaining to  $\text{YBa}_2\text{Cu}_3\text{O}_{7-\delta}$  materials and empirical formulas. A comparison with the performance characteristics of copper communication links operating at 80 K temperature indicates that, despite some minor drawbacks such as no means of signal power amplification, a high- $T_c$  superconductor material offer significant advantages over a normal metal in ultralarge-scale-integrated ultrahigh-speed computer components. The authors thank V.P. Andratskiy for helpful discussions. Figures 4; references 6.

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